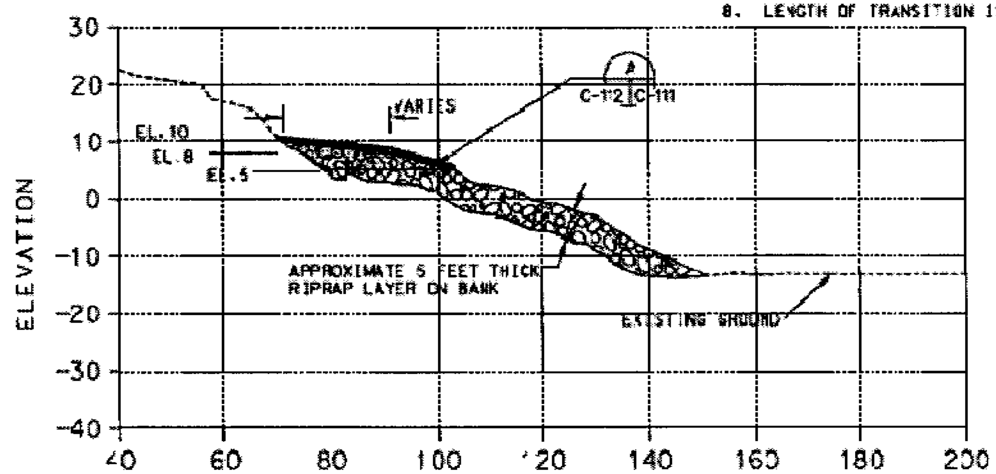
Attachment A
Site Cross Sections

Pocket Area Sites

CONSTRUCTION NOTES:

1. WATER LEVEL AT TIME OF CONSTRUCTION IS EXPECTED TO VARY FROM EL. 3.0 TO EL. 6.0. RIPRAP BERM BACKFILL SHALL BE PLACED WHEN WATER LEVEL IS AT EL. 5.0 OR LOWER ONLY.
2. PLACE RIPRAP BERM BACKFILL IN RIPRAP VOIDS DOWN TO EL. 5.0.
3. PLACE "RIPRAP BERM BACKFILL" IN RIPRAP FROM EL. 5.0 TO 1 FOOT ABOVE RIPRAP SURFACE.
4. PROTECT STANDING TREES IN PLACE.
5. FALLEN TREES AND LOGS TO REMAIN IN PLACE. MAINTAIN RIPRAP COVER OVER FALLEN TREES BY INCREASING RIPRAP HEIGHT EQUAL THEIR DIAMETER (HUMP OF THE RIPRAP).
6. SLOPE VARIES ON SECTIONS. MAINTAIN 5-FOOT RIPRAP THICKNESS.
7. FOR PLANTING SEE LANDSCAPE REVEGETATION SITE PLAN AND DETAILS #1 AND #2.
8. LENGTH OF TRANSITION IS 10 FEET AT START AND ? FEET AT END.



SITE 49.9L R-1, TYPICAL CROSS SECTION

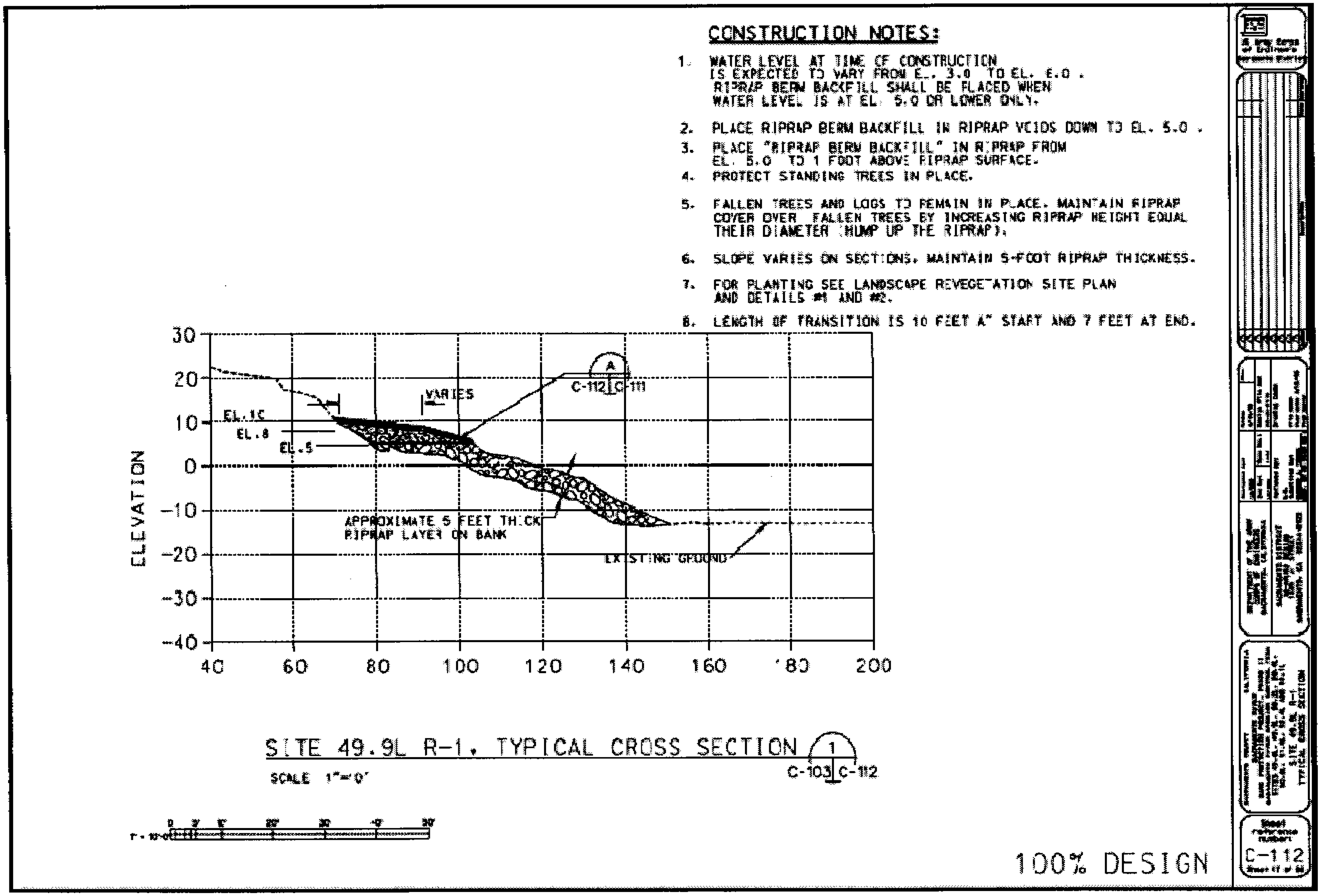
SCALE 1"=10'

C-103 C-112

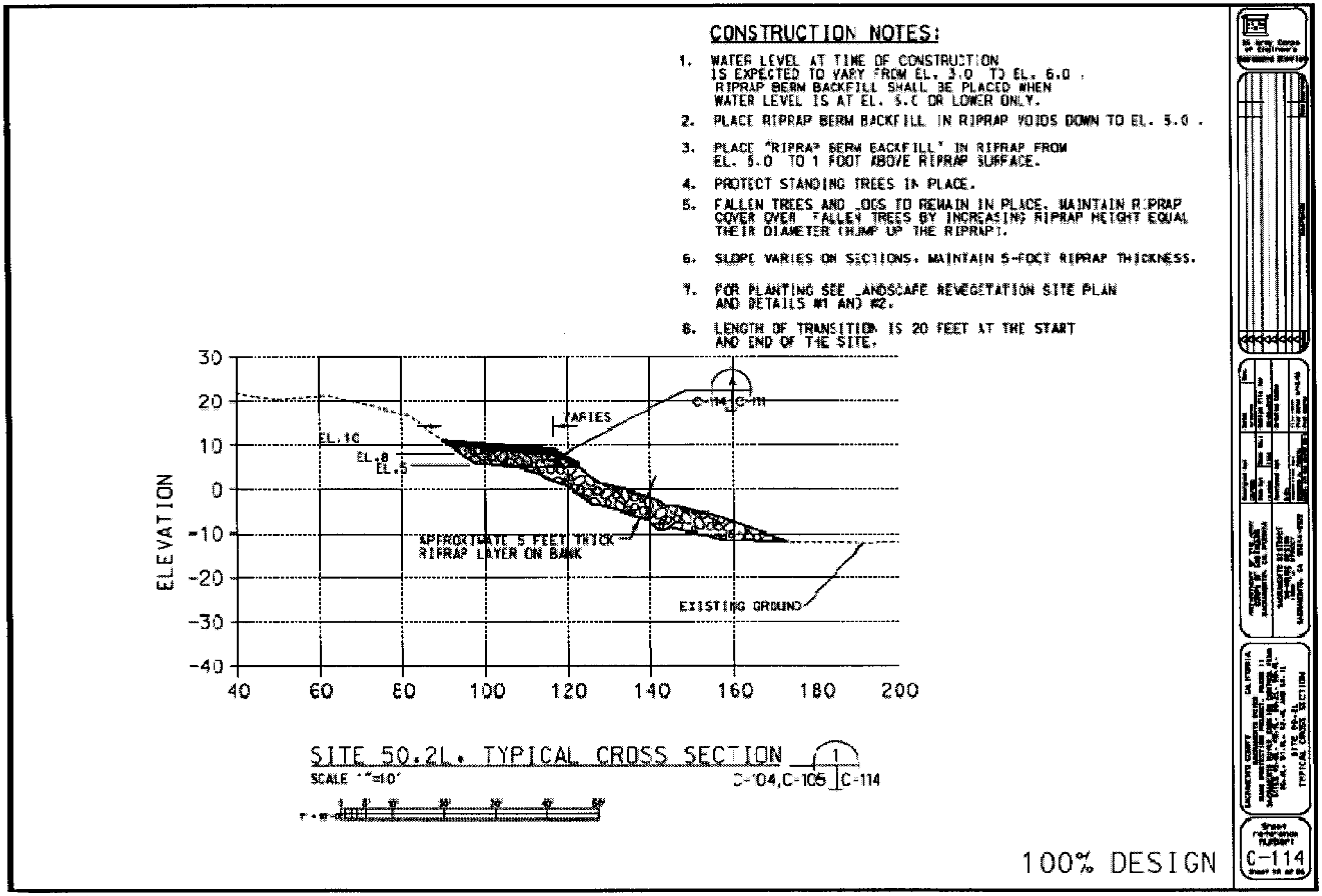
100% DESIGN

C-112

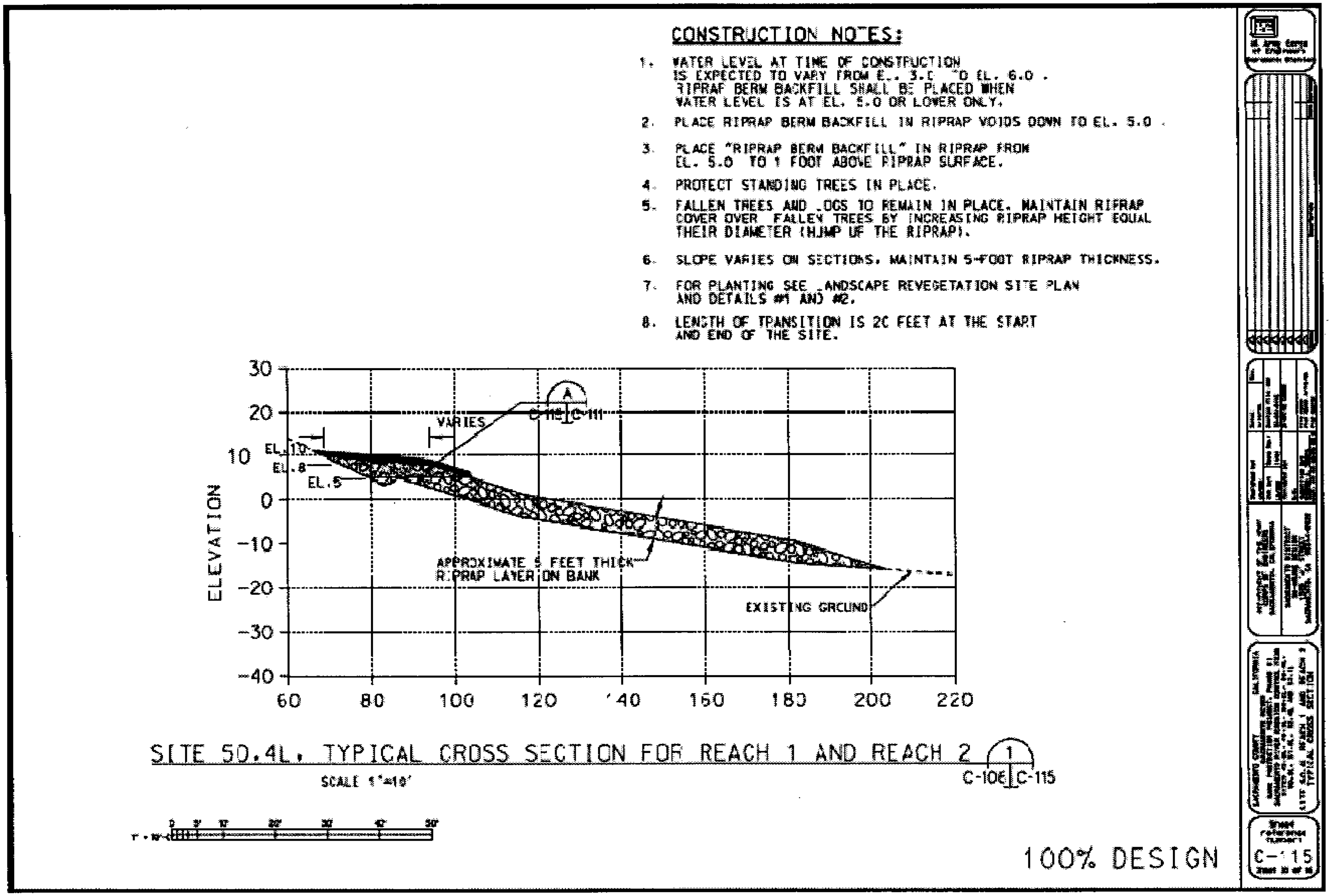
RM 49.6 Typical Cross Section



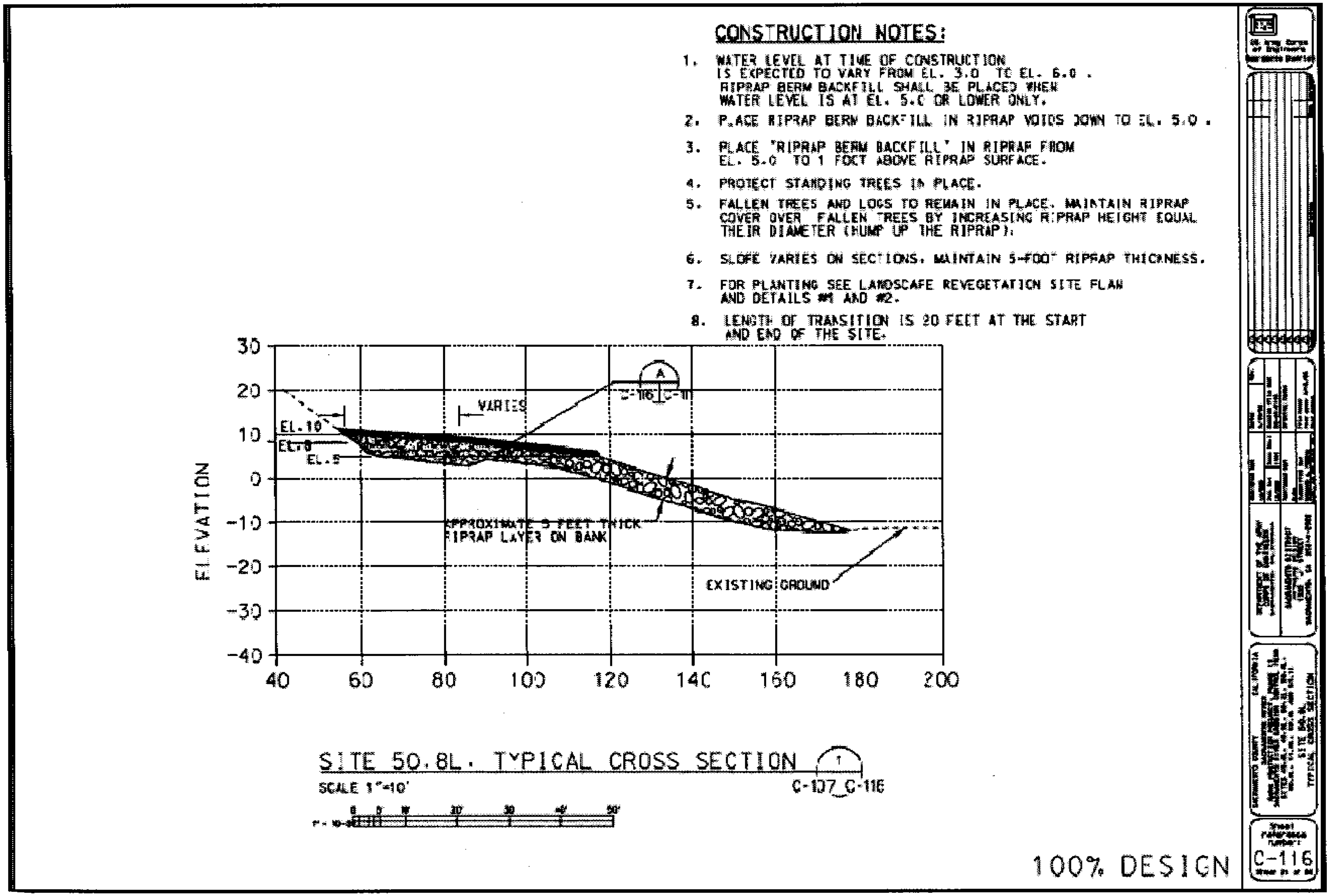
RM 49.9 Typical Cross Section



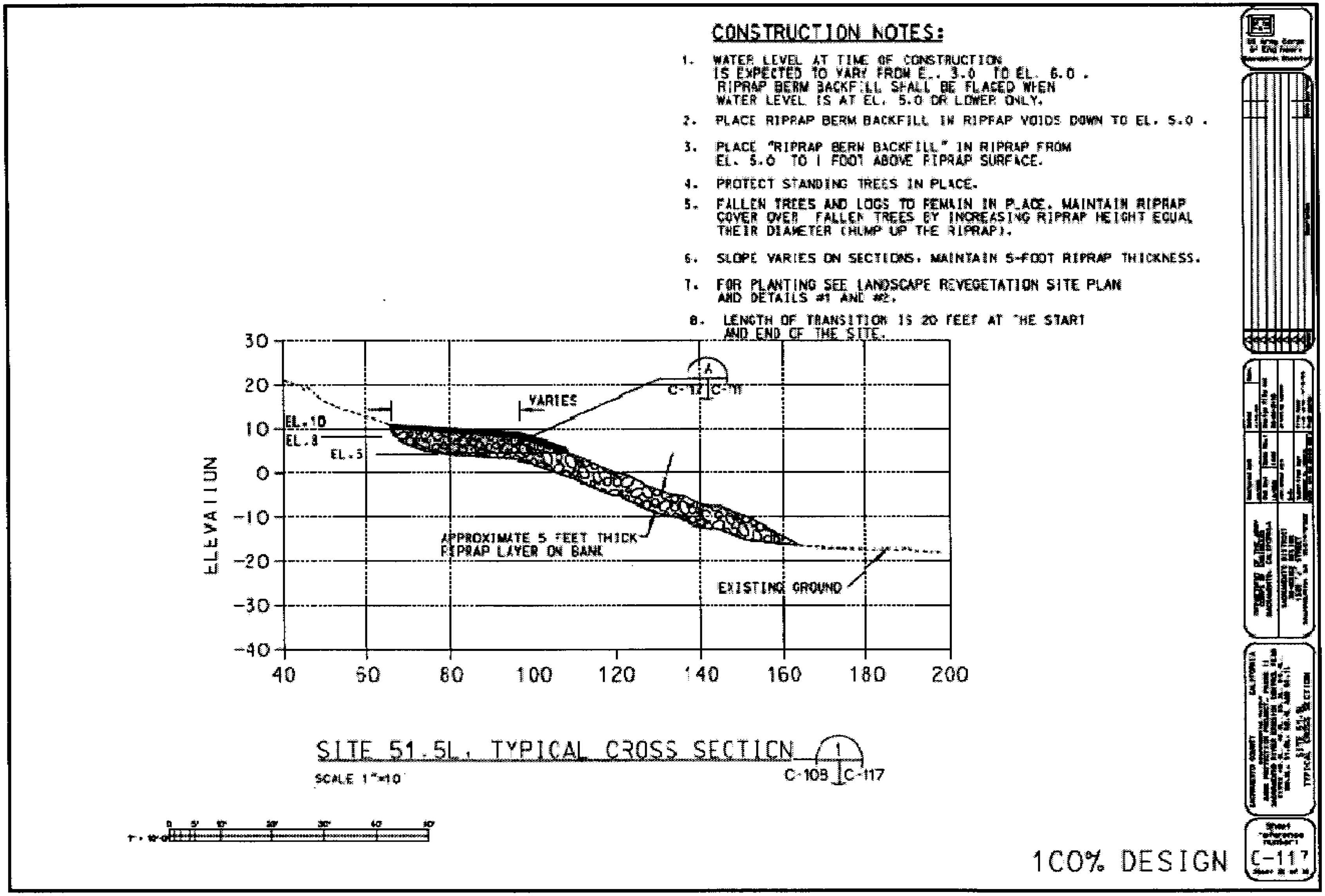
RM 50.2 Typical Cross Section



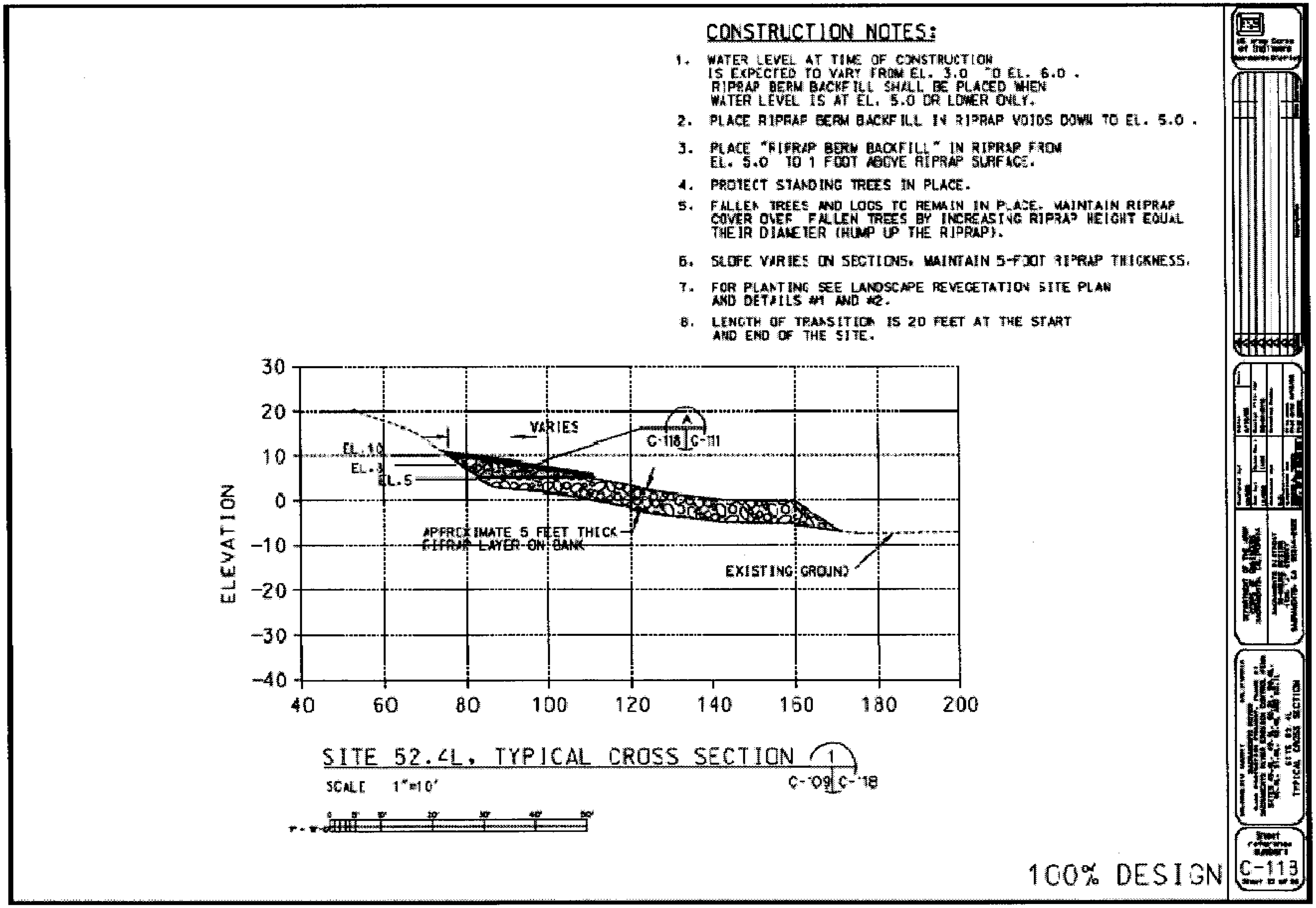
RM 50.4 Typical Cross Section



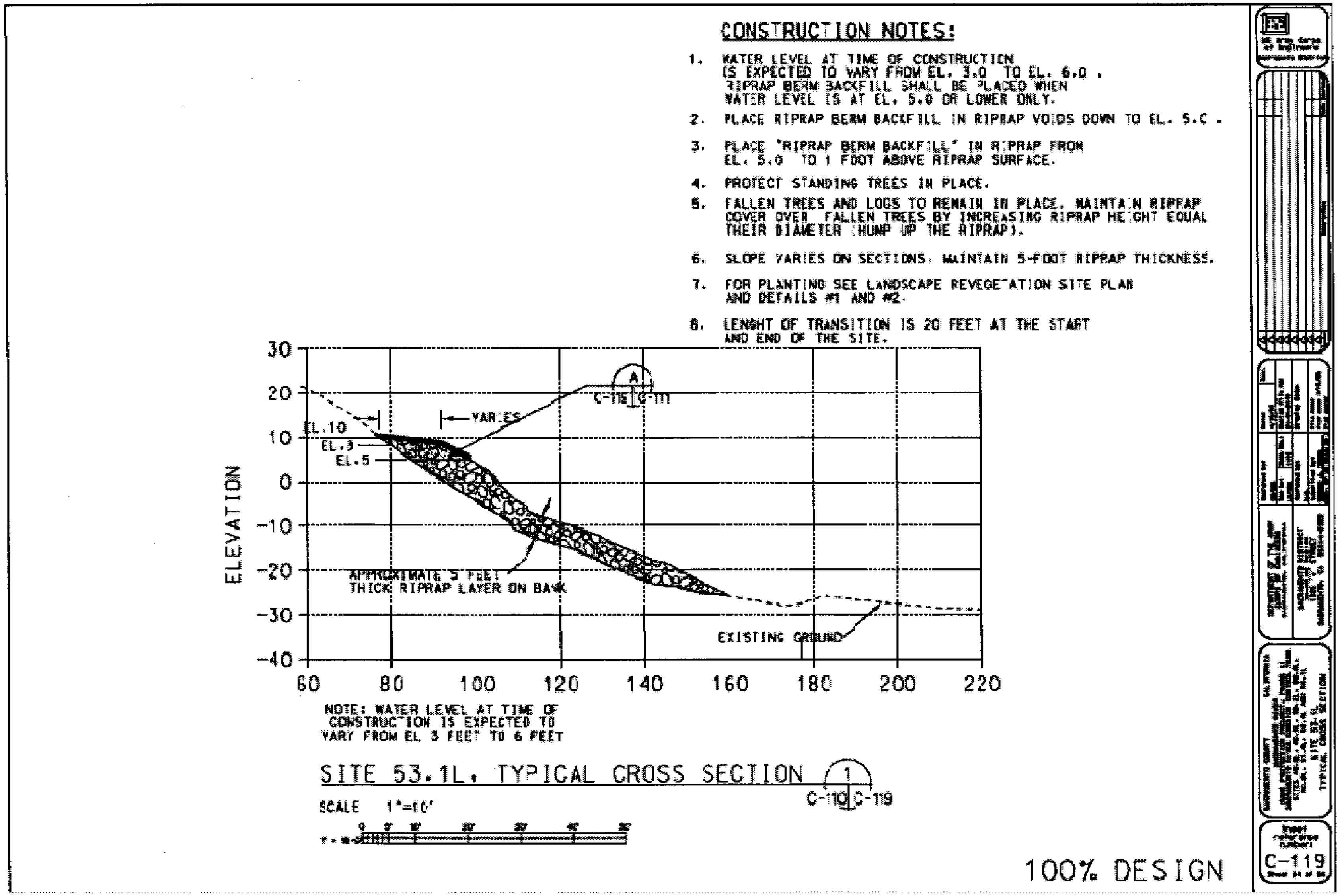
RM 50.8 Typical Cross Section



RM 51.5 Typical Cross Section

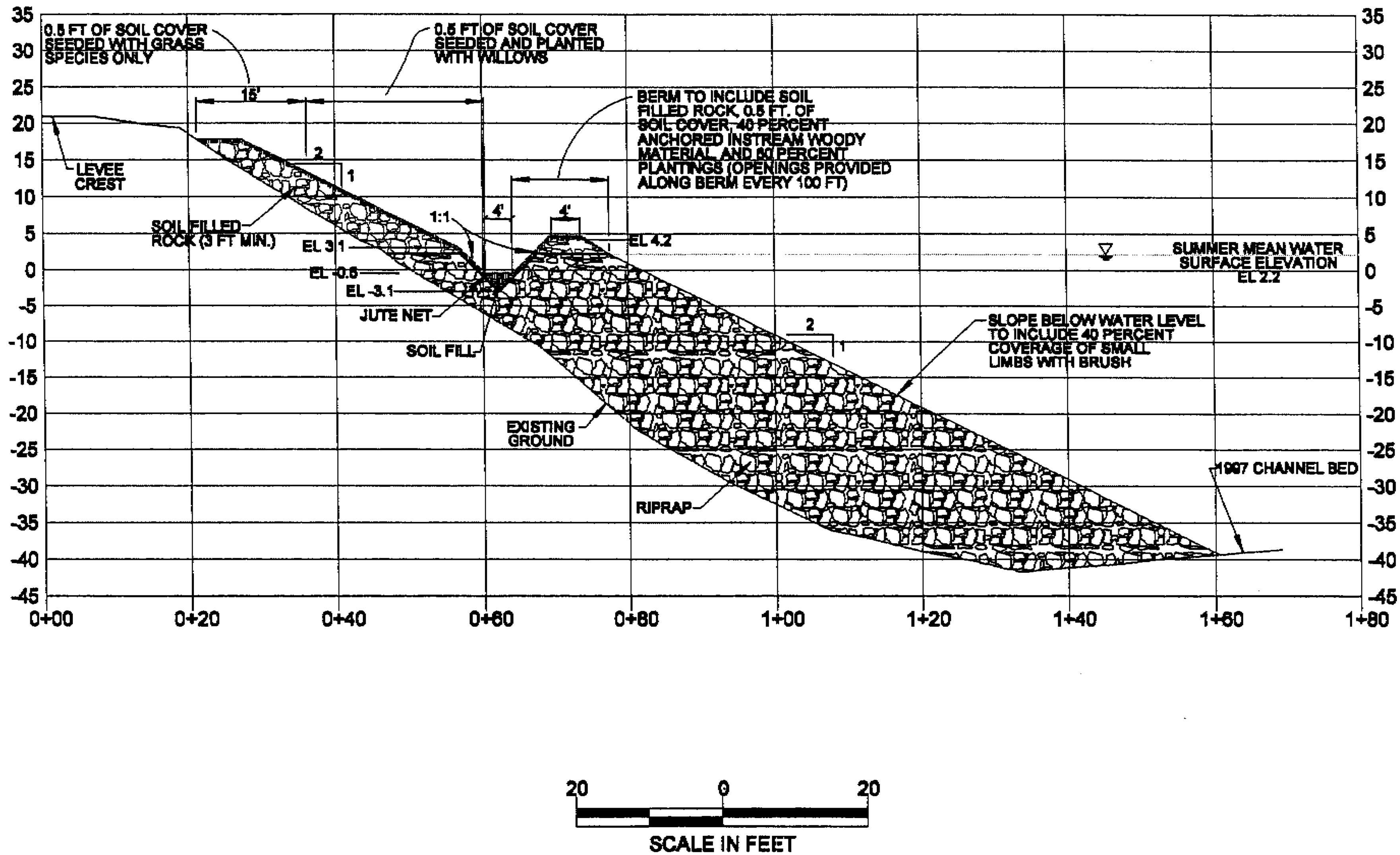


: RM 52.4 Typical Cross Section



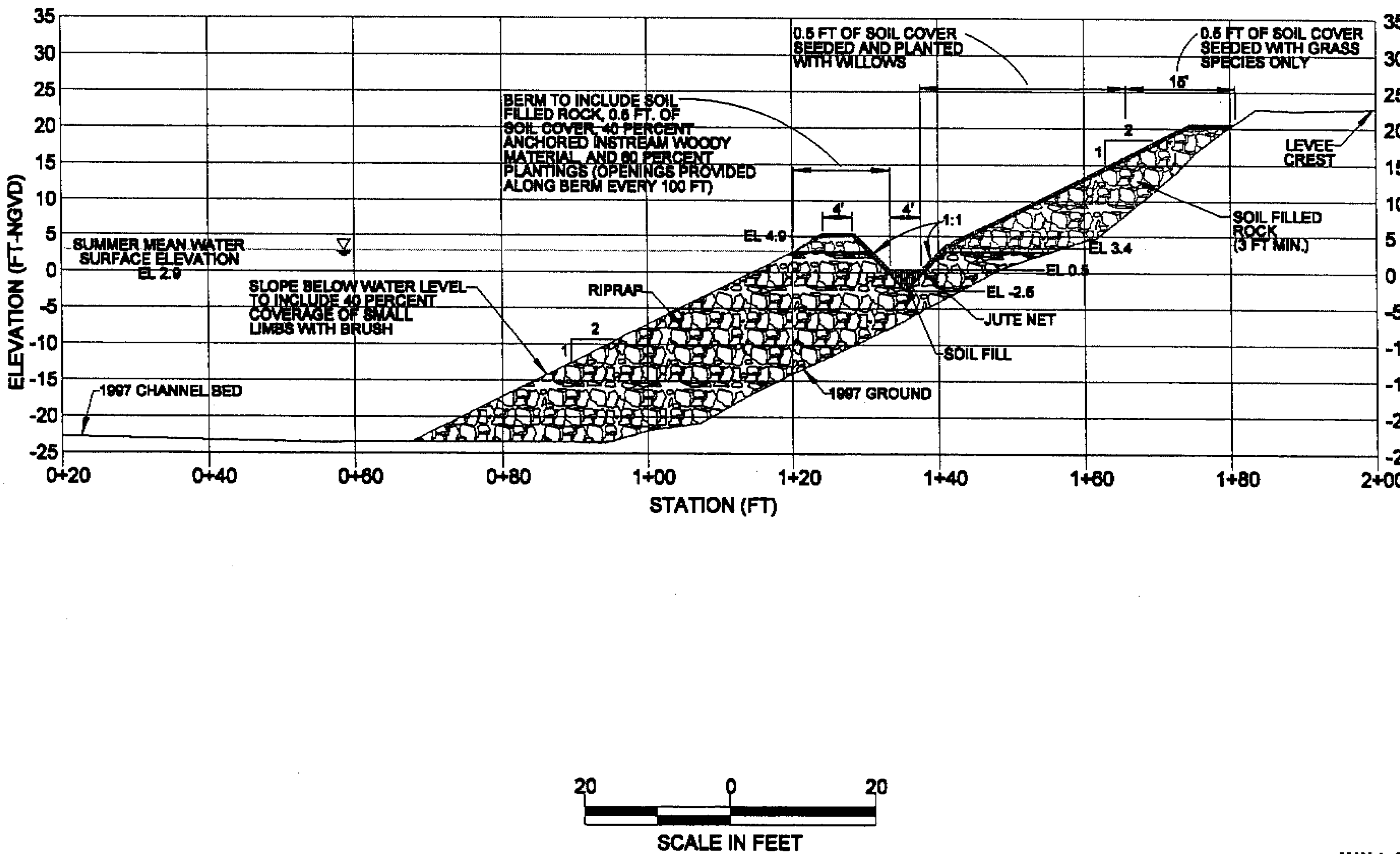
RM 53.1 Typical Cross Section

Corps Additional 5 Sites



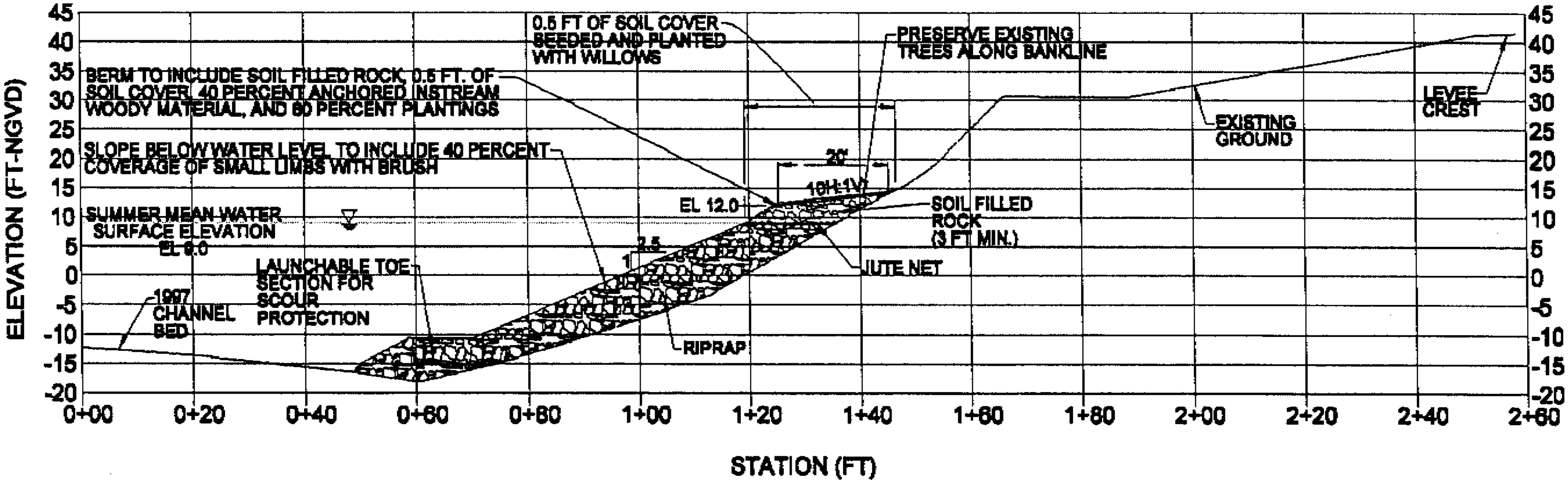
MAY 4, 2006

Typical Design Cross Section at Sacramento River Mile 26.9L



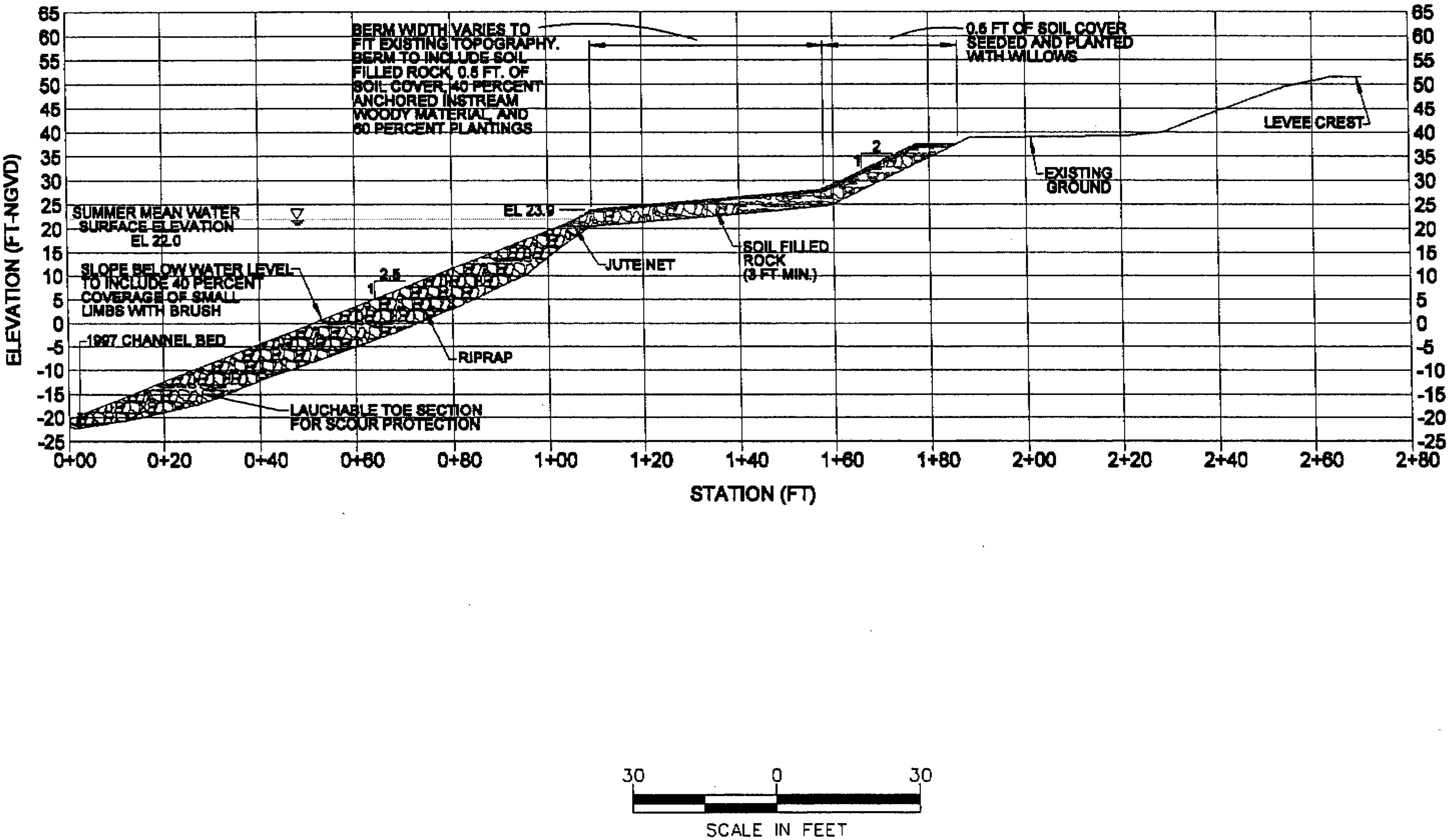
MAY 4, 2006

Typical Design Cross Section at Sacramento River Mile 34.5R



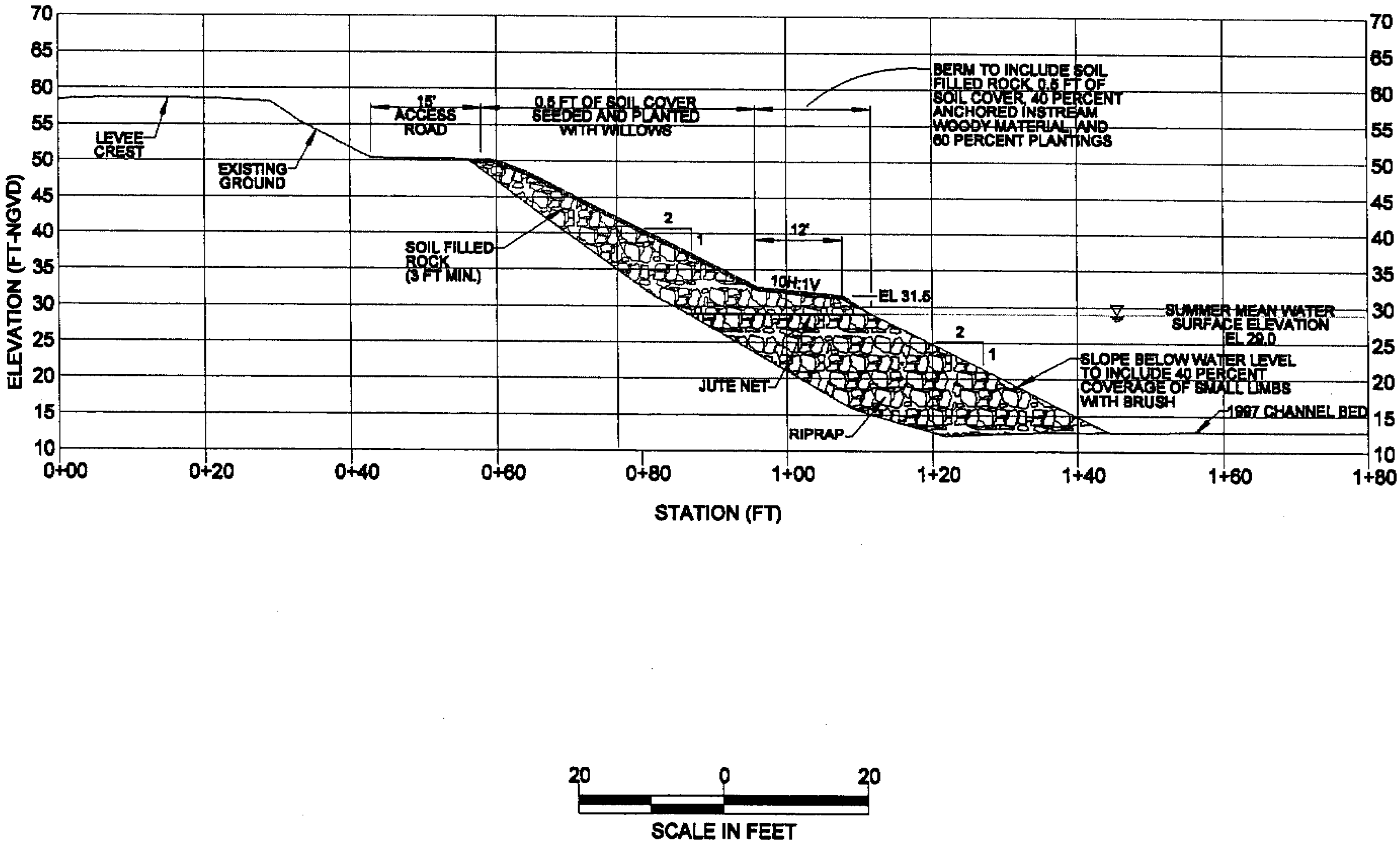
MAY 4, 2006

Typical Design Cross Section at Sacramento River Mile 72.2R



MAY 4, 2006

Typical Design Cross Section at Sacramento River Mile 99.3R



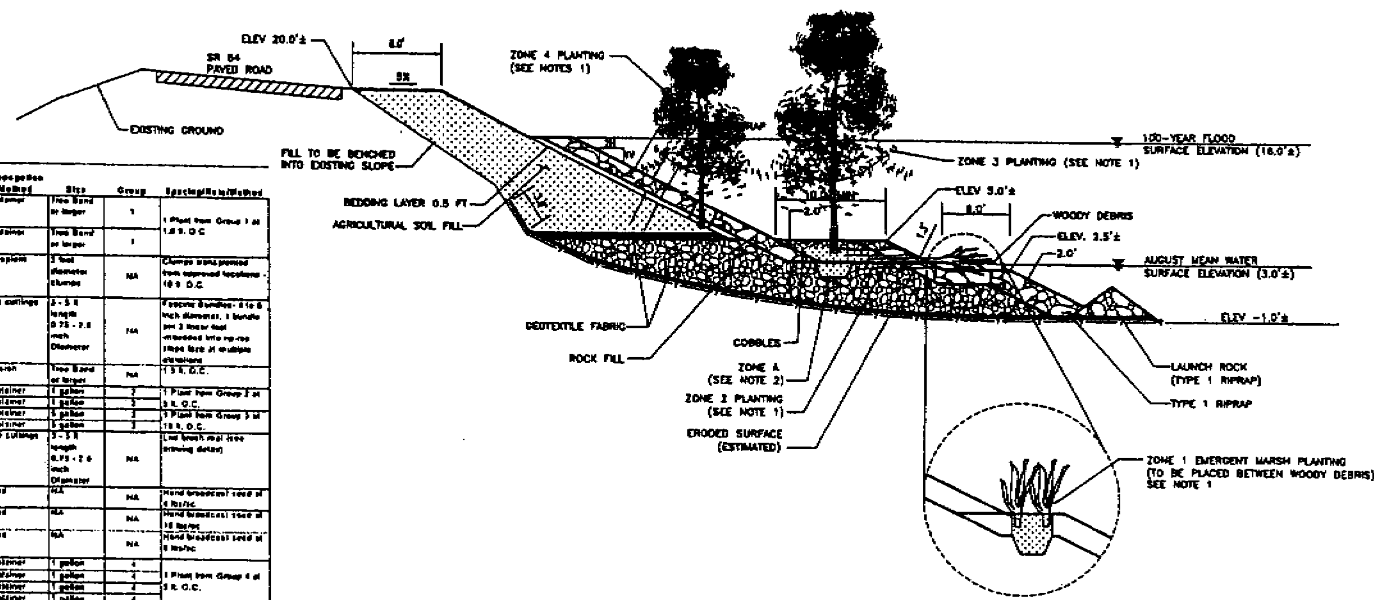
MAY 4, 2006

Typical Design Cross Section at Sacramento River Mile 123.5L

NOTES:

1. Four different zones of plantings are used at this site. The zones are shown in the typical cross section, and the species to be planted and their spacing are shown in the table at the left. See also Specification Section 2850.

2. After placement of rock fill in Zone 2 and riprap in Zone 4, fill gaps between rocks with planting soil to the maximum depth possible prior to planting on top.



TYPICAL CROSS SECTION

NTS

Typical Planting Schedule - DWR Levee Repair

Zone	Elevation (NAVD 88)	Botanical Name	Common Name	Propagation Method	Size	Group	Spacing/Note/Method
1 (emergent bench)		Scirpus acutus	common tule	Container	Tree Band or larger	1	1 Plant from Group 1 at 1.5 ft. O.C.
		Scirpus californicus	California bulrush	Container	Tree Band or larger	1	
		Scirpus spp. (includes S. acutus and/or S. californicus)	bulrush/tule species	transplant	3 foot diameter clumps	NA	Clumps transplanted from approved locations - 10 ft. O.C.
2 (transition slope)		Salix spp. (includes S. [illegible], S. lasiolepis, S. gooddingii, S. lucida, S. exigua)	willow species	pole cuttings	3 - 5 ft length 0.75 - 2.0 inch Diameter	NA	Fascine Bundles - 4 to 6 inch diameter, 1 bundle per 3 linear feet imbedded into rip-rap slope face at multiple elevations
3 (median bench)		Leymus triticoides	creeping wildrye	Division	Tree Band or larger	NA	1.5 ft. O.C.
		Grindelia camporum	gum plant	Container	1 gallon	2	1 Plant from Group 2 at 5 ft. O.C.
		Deschampsia caespitosa	tufted hair-grass	Container	1 gallon	2	
		Populus fremontii	Fremont's cottonwood	Container	5 gallon	3	1 Plant from Group 3 at 10 ft. O.C.
		Acer negundo	boxelder	Container	5 gallon	3	
		Salix spp. (includes S. [illegible], S. lasiolepis, S. gooddingii, S. lucida, S. exigua)	willow species	pole cuttings	3 - 5 ft length 0.75 - 2.0 inch Diameter	NA	Live brush mat (see drawing detail)
		Achillea millefolium	common yarrow	Seed	NA	NA	Hand broadcast seed at 4 lbs/ac
		Hordeum brachyantherum	meadow barley	Seed	NA	NA	Hand broadcast seed at 10 lbs/ac
		Artemisia douglasiana	mugwort	Seed	NA	NA	Hand broadcast seed at [illegible] lbs/ac
4 (levee slope)		Rhamnus californica	California coffeeberry	Container	1 gallon	4	1 Plant from Group 4 at 5 ft. O.C.
		Rosa californica	California rose	Container	1 gallon	4	
		Rubus ursinus	California blackberry	Container	1 gallon	4	
		Baccharis pilularis	coyote brush	Container	1 gallon	4	
		Populus fremontii	Fremont's cottonwood	Container	5 gallon	5	1 Plant from Group 5 at 10 ft. O.C. Plant at lower portion of planting zone.
		Acer negundo	box elder	Container	5 gallon	5	
		Alnus rhombifolia	white alder	Container	5 gallon	5	
		Quercus lobata	Valley oak	Container	5 gallon	6	1 Plant from Group 6 at 10 ft. O.C. Plant at higher portion of planting zone
		Platanus racemosa	sycamore	Container	5 gallon	6	
		Bromus carinatus	California brome	Seed	NA	NA	10 lbs/ac
		Elymus glaucus	blue wild rye	Seed	NA	NA	[illegible] lbs/ac
		Nassella pulchra	purple needle grass	Seed	NA	NA	5 lbs/ac
		Hordeum californicum	California barley	Seed	NA	NA	[illegible] lbs/ac
		Achillea millefolium	Common yarrow	Seed	NA	NA	1 lbs/ac
		Aster chilensis	Common aster	Seed	NA	NA	1 lbs/ac
		Bromus carinatus	California brome	Seed	NA	NA	[illegible] lbs/ac
		Eschscholzia californica	California poppy	Seed	NA	NA	1 lbs/ac
		Hordeum brachyantherum	meadow barley	Seed	NA	NA	4 lbs/ac
		Lupinus bicolor	miniature lupine	Seed	NA	NA	1 lbs/ac

NA = Not Applicable

URS

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
FLOOD MANAGEMENT

STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR

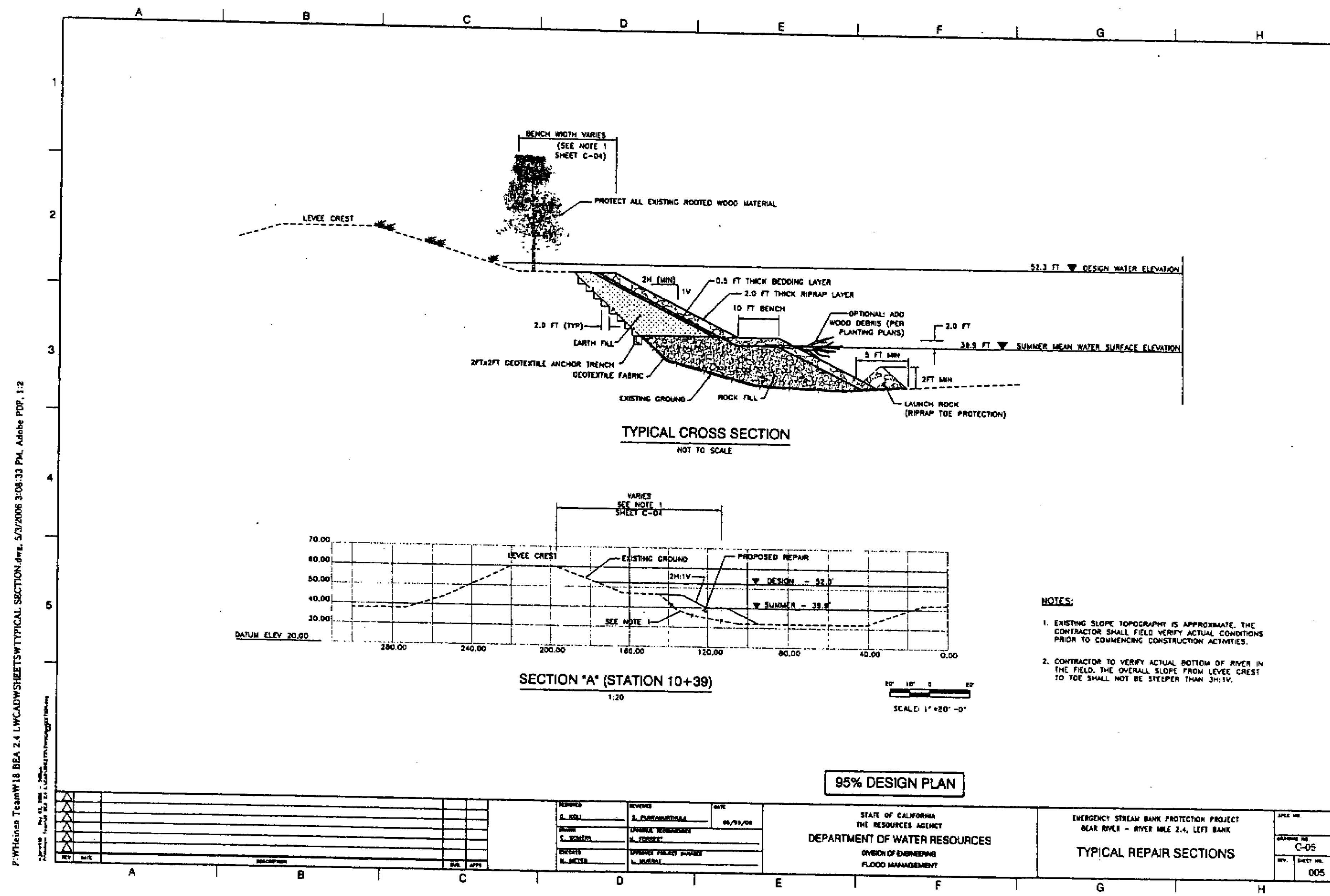
SITE 38CAS 16.5L TYPICAL SECTION

C-05

005

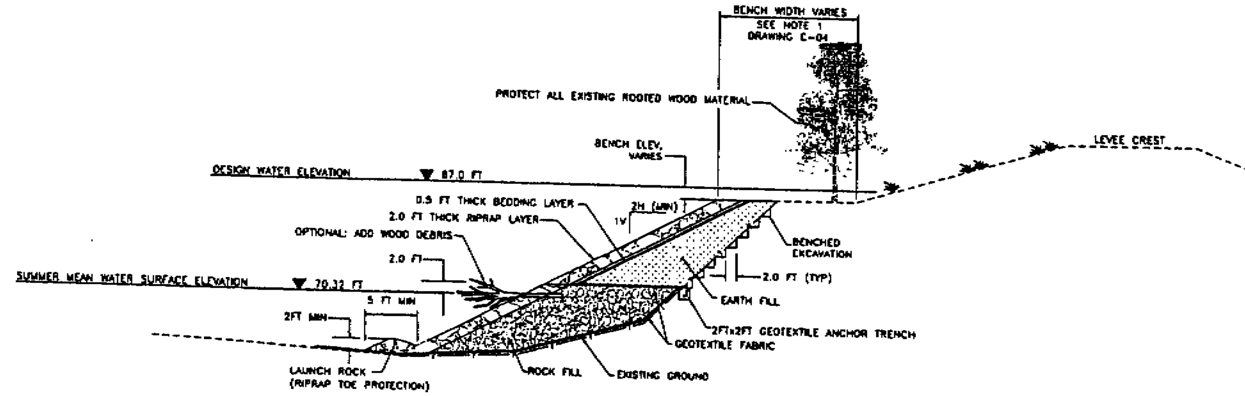
Figure 14
Typical Cross Section at Cache Slough, RM 16.5

DWR Sites



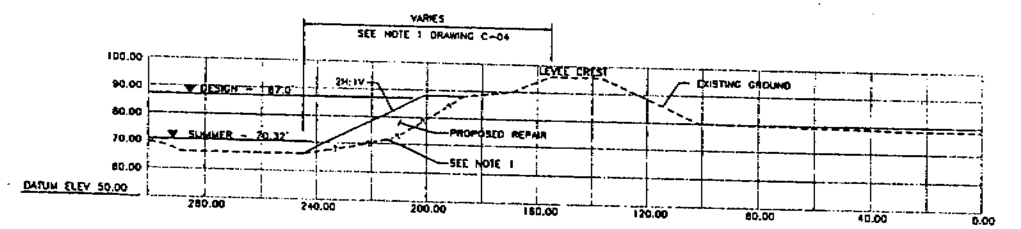
Typical Cross Section at Bear River, RM 2.4

P:WHeinen TeamW19 BEA 10.1 RWCADDWSHEETSWTYPICAL SECTION.dwg, 5/3/2006 5:56:35 PM, Adobe PDF, 1:2



TYPICAL CROSS SECTION

NTS



SECTION A

1:20

SCALE: 1" = 20' -0"

NOTES:

1. EXISTING SLOPE TOPOGRAPHY IS APPROXIMATE. THE CONTRACTOR SHALL FIELD VERIFY ACTUAL CONDITIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITIES.
2. CONTRACTOR TO VERIFY ACTUAL BOTTOM ELEVATION OF RIVER IN THE FIELD. THE OVERALL SLOPE FROM LEVEE CREST TO TOE SHALL NOT BE STEEPER THAN 3H:1V.

95% DESIGN PLAN

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
FLOOD MANAGEMENT

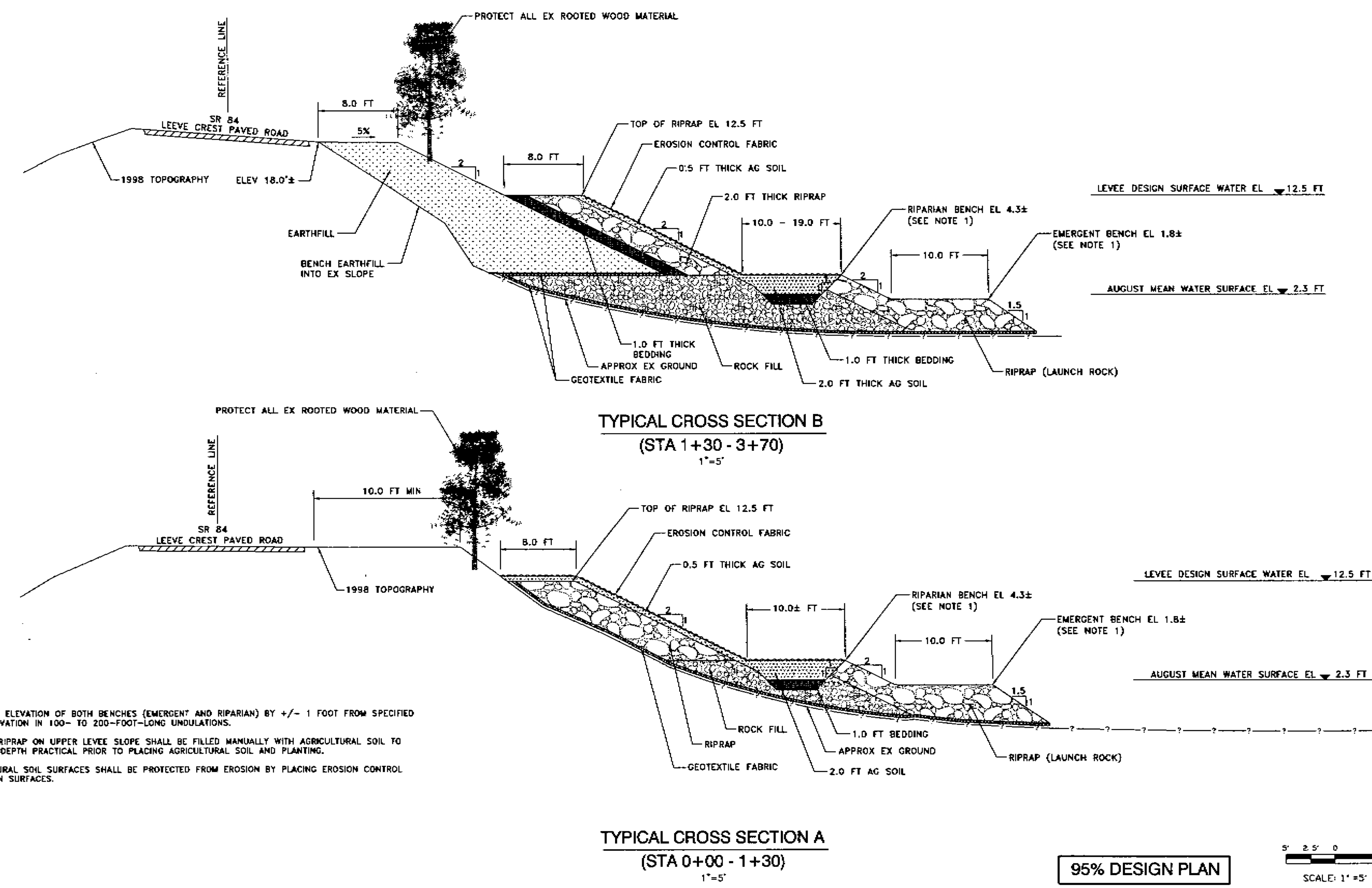
EMERGENCY STREAM BANK PROTECTION PROJECT
BEAR RIVER – RIVER MILE 10.1, RIGHT BANK

TYPICAL REPAIR SECTIONS

C-05

005

Typical Cross Section at Bear River, RM 10.1



NOTES:

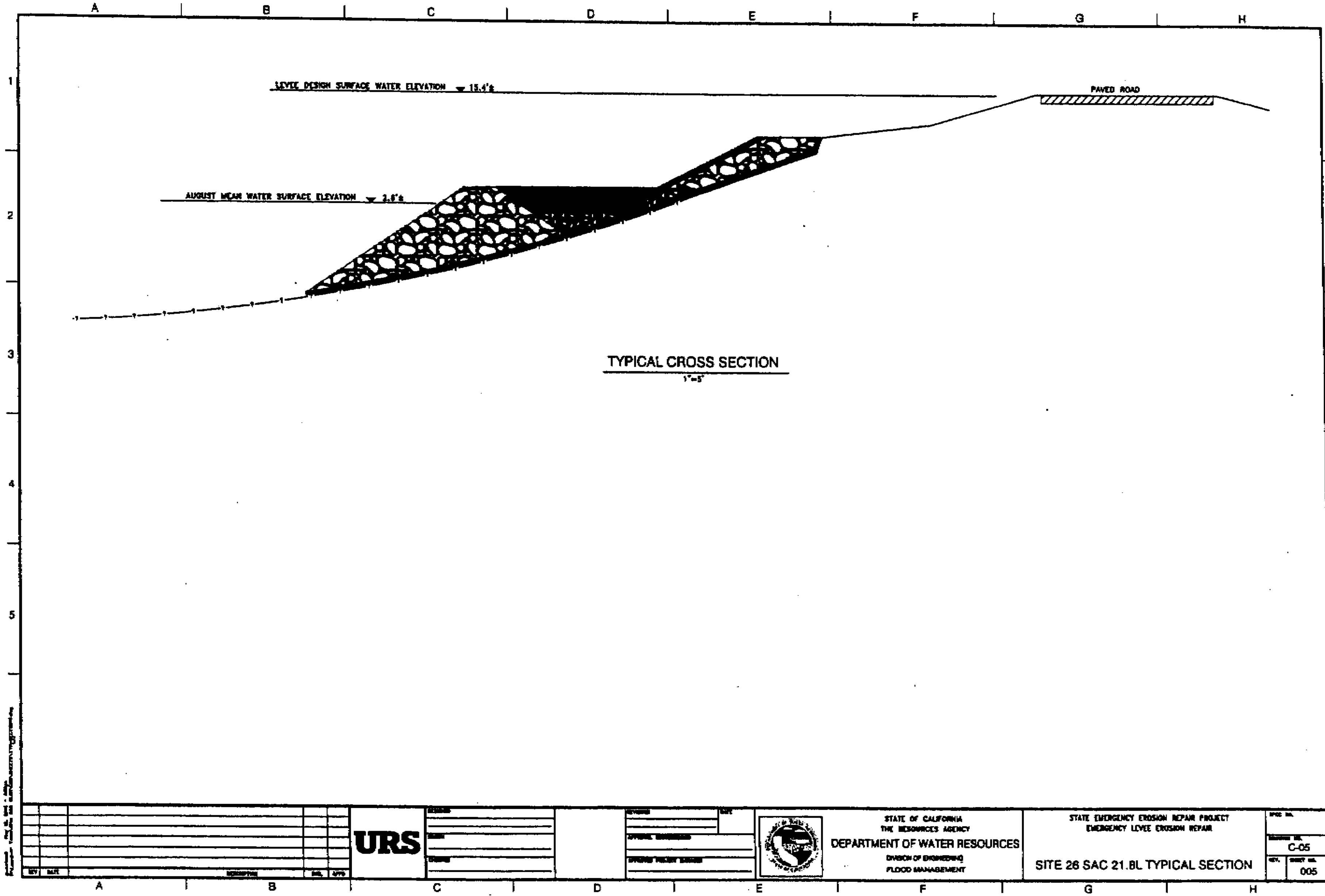
1. VARY TOP ELEVATION OF BOTH BENCHES (EMERGENT AND RIPARIAN) BY +/- 1 FOOT FROM SPECIFIED MEAN ELEVATION IN 100- TO 200-FOOT-LONG UNDULATIONS.
2. GAPS IN RIPRAP ON UPPER LEVEE SLOPE SHALL BE FILLED MANUALLY WITH AGRICULTURAL SOIL TO MAXIMUM DEPTH PRACTICAL PRIOR TO PLACING AGRICULTURAL SOIL AND PLANTING.
3. AGRICULTURAL SOIL SURFACES SHALL BE PROTECTED FROM EROSION BY PLACING EROSION CONTROL FABRIC ON SURFACES.

DESIGNED S. PUNYAMURTHULA | APPROVAL RECOMMENDED U. LUSCHER | DRAWN S. GODINEZ | APPROVAL BY S. SALAH-MARS | CHECKED M. FORREST | URS | STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES DIVISION OF ENGINEERING FLOOD MANAGEMENT

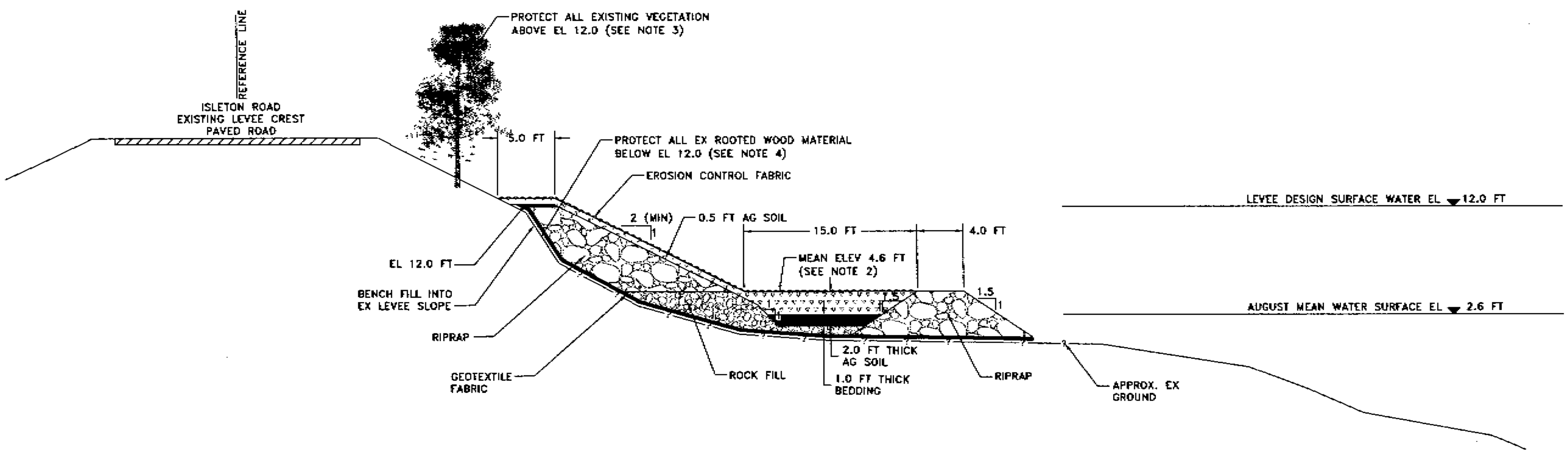
STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR
CACHE SLOUGH-MILE 16.5L & 21.8R, STEAMBOAT SLOUGH-MILE 16.2R, AND SACRAMENTO RIVER-MILE 20.8L, 26.5L & 32.5R
CACHE SLOUGH-MILE 16.5, LEFT BANK
TYPICAL REPAIR SECTIONS

DRAWING NO. C-03 | SHEET NO. 007

Typical Cross Section at Cache Slough RM 16.5

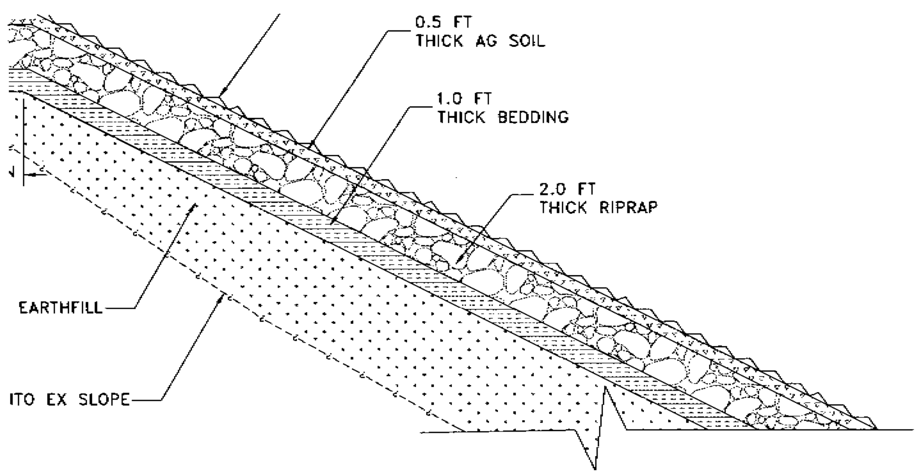


Typical Cross Section at Cache Slough, RM 21.8



TYPICAL CROSS SECTION

1"=5'



TRANSITION DETAIL (ABOVE WATER LEVEL)

NTS
(SEE DWG C-05)

NOTES:

1. EXISTING ROCK FILL BETWEEN ABOUT STA 3+60 AND STA 2+50 SHALL BE REMOVED DOWN TO THE SPECIFIED TOP OF ROCK FILL ELEVATION.
2. THE FINISHED ELEVATION OF THE TOP OF THE RIPARIAN BENCH SHALL BE VARIED BY +/- 1 FOOT IN LONG (100 TO 200 FEET) IRREGULAR UNDULATIONS ALONG THE BENCH.
3. THE TOP PART OF THE EXISTING LEVEE SLOPE ABOVE THE TOP OF THE FILL SLOPE AT ELEVATION 12.0 FT SHALL BE PROTECTED FROM ANY CONSTRUCTION DISTURBANCE.
4. EXISTING TREES AND LARGER SHRUBS BELOW ELEVATION 12.0 FT SHALL BE LEFT IN PLACE AND PROTECTED FROM CONSTRUCTION DAMAGE. TREES SHALL BE PROTECTED FROM DIRECT CONTACT WITH LARGE ROCKS, AND FILL SHALL BE PLACED CAREFULLY (BY HAND IF REQUIRED) AROUND TREE TRUNKS.
5. GAPS IN ROCK FILL UNDER RIPARIAN BENCH AND IN RIPRAP ON UPPER LEVEE SLOPE SHALL BE FILLED WITH AGRICULTURAL SOIL TO MAXIMUM EXTENT AND DEPTH PRACTICAL BEFORE PLACING OVERLYING AGRICULTURAL SOIL.
6. AGRICULTURAL SOIL SURFACES SHALL BE PROTECTED FROM EROSION BY PLACING EROSION CONTROL FABRIC ON SURFACES.

5' 2.5' 0 5'
SCALE: 1"=5'

95% DESIGN PLAN

REV.	DATE	DESCRIPTION	SUB.	APPD

DESIGNED S. PUNYAMURTHULA
DRAWN M. SAVANNAH
CHECKED M. FORREST REG. NO. C-27855
APPROVAL RECOMMENDED U. LUSCHER REG. NO. CE-17851
APPROVAL BY S. SALAH-MARS REG. NO. CE-30445

URS

REVIEWED REG. CE. NO. 52497
APPROVAL RECOMMENDED REG. CE. NO. 30612
APPROVED PROJECT MANAGER REG. CE. NO. 29506
DATE

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
FLOOD MANAGEMENT

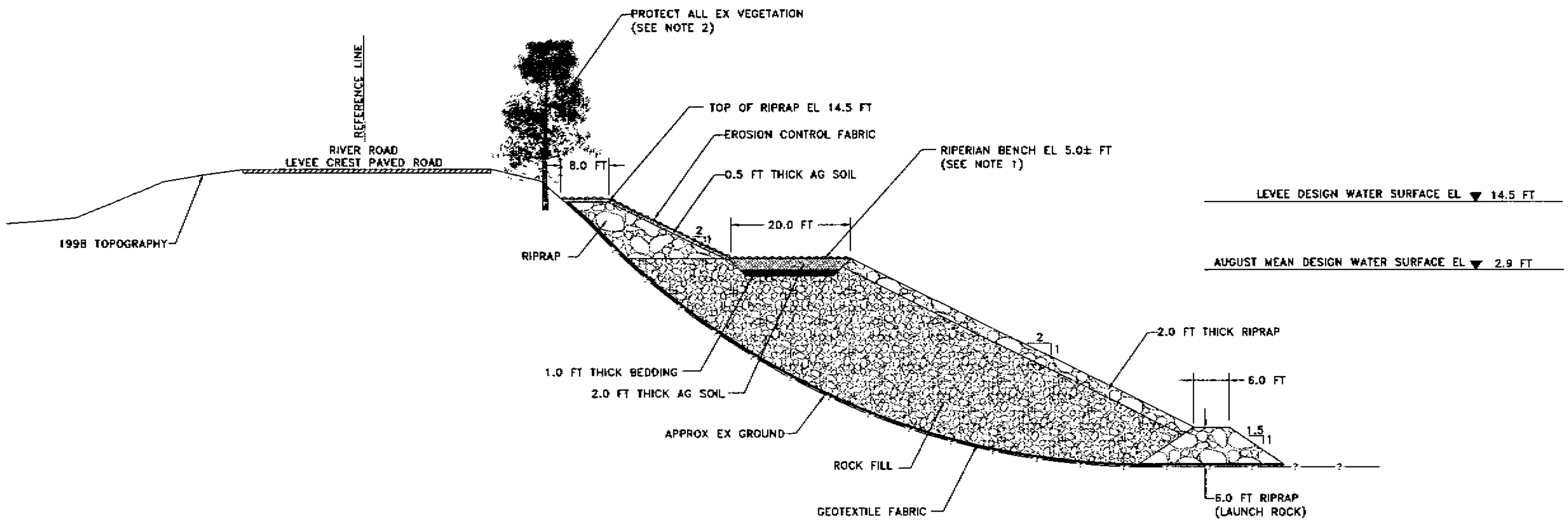
STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR
CACHE SLOUGH-MILE 16.5L & 21.8R, STEAMBOAT SLOUGH-MILE 16.2R, AND SACRAMENTO RIVER-MILE 20.8L, 26.5L & 32.5R
SACRAMENTO RIVER-MILE 20.8, LEFT BANK
TYPICAL REPAIR SECTION AND DETAILS

SPEC NO.
DRAWING NO. C-13
REV. SHEET NO. 017

Typical Cross Section at Sacramento River RM 20.8

NOTES:

1. THE FINISHED ELEVATION OF THE TOP OF THE RIPARIAN BENCH SHALL BE VARIED BY +/- 1 FOOT IN LONG (100 TO 200 FEET) IRREGULAR UNDULATIONS ALONG THE BENCH.
2. EXISTING TREES AND LARGER SHRUBS ON THE LEVEE SLOPE SHALL BE LEFT IN PLACE AND PROTECTED FROM CONSTRUCTION DAMAGE. TREES SHALL BE PROTECTED FROM DIRECT CONTACT WITH LARGE ROCKS, AND FILL SHALL BE PLACED CAREFULLY (BY HAND IF REQUIRED) AROUND THE TREE TRUNKS.
3. GAPS IN RIPRAP ON UPPER LEVEE SLOPE SHALL BE MANUALLY FILLED WITH AGRICULTURAL SOIL TO MAXIMUM DEPTH PRACTICAL BEFORE PLACING OVERLYING AGRICULTURAL SOIL.
4. AGRICULTURAL SOIL SURFACES SHALL BE PROTECTED FROM EROSION BY PLACING EROSION CONTROL FABRIC ON SURFACES.
5. BECAUSE OF THE BUSY URBAN STREET ON TOP OF THE LEVEE, REPAIR WORK SHOULD PREFERABLY BE DONE FROM BARGES IN THE RIVER. THIS WILL REQUIRE TEMPORARY REMOVAL OF THE DOCK NOW LOCATED OFFSHORE FROM THE SITE. CONTRACTOR SHALL MAKE NECESSARY ARRANGEMENTS WITH THE OWNER OF THE DOCK.



TYPICAL CROSS SECTION

1"=10'

SCALE: 1"=10'

95% DESIGN PLAN

DESIGNED: S. PUNYAMURTHULA DRAWN: S. GOOMEZ CHECKED: M. FORREST, REG. NO. C-27855	APPROVAL RECOMMENDED: U. LUSCHER, REG. NO. CE-17851 APPROVAL BY: S. SALAH-MARS, REG. NO. CE-50465	URS	REVIEWED / DATE APPROVAL RECOMMENDED APPROVED PROJECT MANAGER	STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES DIVISION OF ENGINEERING FLOOD MANAGEMENT

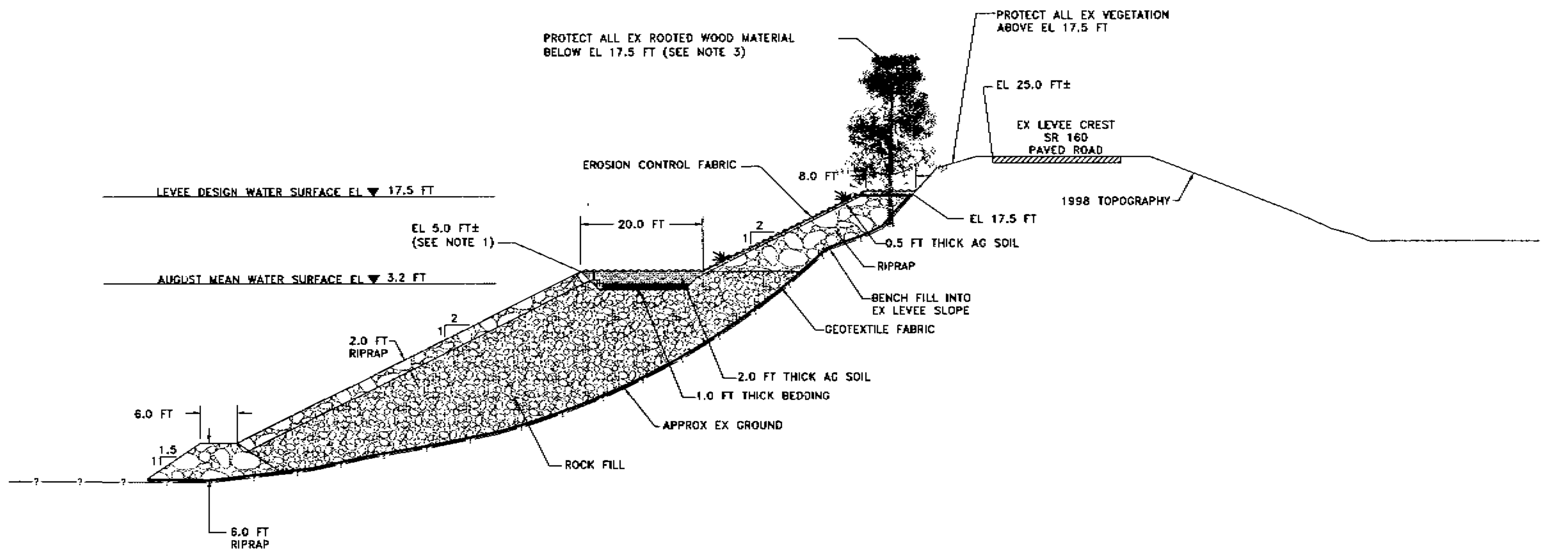
STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR
CACHE SLOUGH-MILE 18.5 & 21.8, STEAMBOAT SLOUGH-MILE 16.2, AND SACRAMENTO RIVER-MILE 20.8, 26.5 & 32.5
SACRAMENTO RIVER-MILE 26.5, LEFT BANK
TYPICAL REPAIRS SECTION

DRAWING NO. C-16 | SHEET NO. 020

REV. | DATE | DESCRIPTION | SUB. | APPD

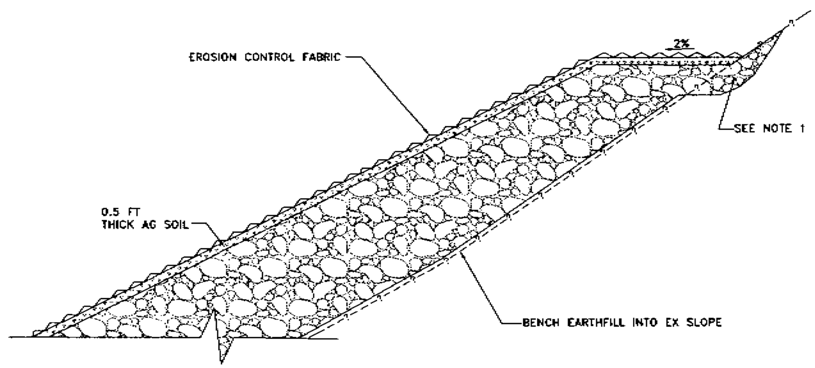
cesomer0 May 18, 2006 - 12:40pm P:\Luscher Team\Site SAC26.5L\CAD\SHEETS\C-16.dwg

Typical Cross Section at Sacramento River RM 26.5



TYPICAL CROSS SECTION

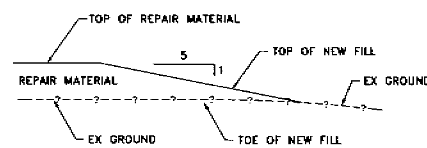
1"=10'



TRANSITION DETAIL (ABOVE WATER LEVEL)

NTS

(SEE DWG C-19)



TRANSITION PROFILE

NTS

NOTES:

1. VARY TOP ELEVATION OF RIPARIAN BENCH BY +/- 1 FOOT FROM SPECIFIED ELEVATION IN 100 TO 200-FOOT-LONG IRREGULAR UNDULATIONS.
2. ALSO VARY HORIZONTAL ALIGNMENT OF BOTH UPPER AND LOWER LEVEE SLOPES BY +/- 5 FEET IN LONG IRREGULAR UNDULATIONS. USE EXISTING SLOPE'S NATURAL UNDULATIONS AS MUCH AS POSSIBLE.
3. EXISTING TREES AND LARGER SHRUBS ON THE LEVEE SLOPE SHALL BE LEFT IN PLACE AND PROTECTED FROM CONSTRUCTION DAMAGE. TREES SHALL BE PROTECTED FROM DIRECT CONTACT WITH LARGE ROCKS, AND FILL SHALL BE PLACED CAREFULLY (BY HAND IF REQUIRED) AROUND THE TREE TRUNKS.
4. GAPS BETWEEN ROCK FILL UNDER RIPARIAN BENCH AND IN RIPRAP ON UPPER LEVEE SLOPE SHALL BE FILLED WITH AGRICULTURAL SOIL TO MAXIMUM DEPTH PRACTICAL PRIOR TO PLACING OVERLYING AGRICULTURAL SOIL AND PLANTING.
5. AGRICULTURAL SOIL SURFACES SHALL BE PROTECTED FROM EROSION BR PLACING EROSION CONTROL FABRIC ON SURFACES.

95% DESIGN PLAN

SCALE: 1"=10'

REV	DATE	DESCRIPTION	SUB.	APPD	DESIGNED: S. PUNTAMURTHULA; DRAWN: M. SAVANNAH; CHECKED: M. FORREST, REG. NO. C-27855	APPROVAL RECOMMENDED: U. LUSCHER, REG. NO. CE-17651; APPROVAL BY: S. SALAH-MARS, REG. NO. CE-50445	URS	REVIEWED; REG. CE. NO. 62497; APPROVAL RECOMMENDED; REG. CE. NO. 30612; APPROVED PROJECT MANAGER; REG. CE. NO. 29388	DATE

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
FLOOD MANAGEMENT

STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR
CACHE SLOUGH-MILE 16.5L & 21.8R, STEAMBOAT SLOUGH-MILE 16.2R, AND SACRAMENTO RIVER-MILE 20.8L, 26.5L & 32.5R
SACRAMENTO RIVER-MILE 32.5, RIGHT BANK
TYPICAL REPAIR SECTION AND DETAIL

SPEC NO. | DRAWING NO. C-20 | REV. | SHEET NO. 024

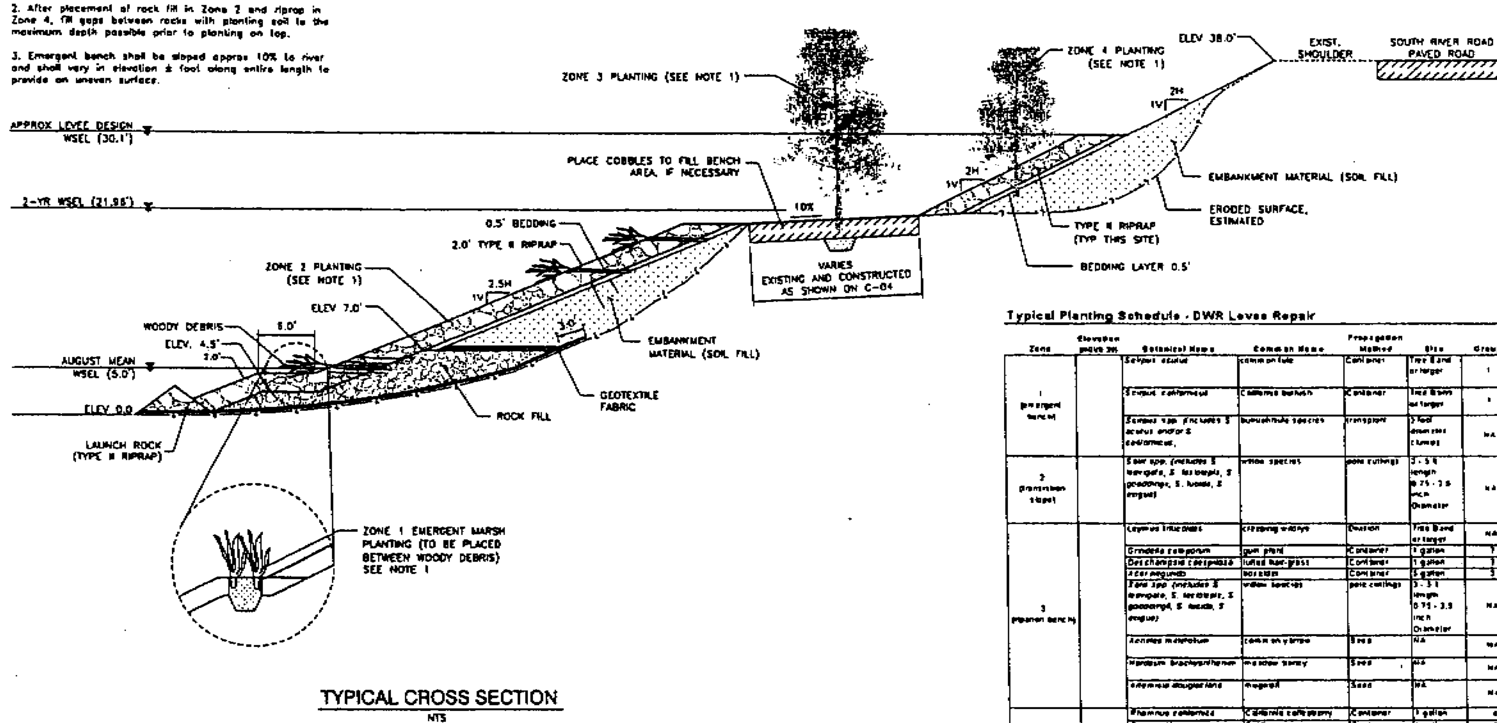
Typical Cross Section at Sacramento River RM 32.5

NOTES:

1. Four different zones of plantings are used at this site. The zones are shown in the typical cross section, and the species to be planted and their spacing are shown in the table at the left. See also Specification Section 2950.

2. After placement of rock fill in Zone 2 and riprap in Zone 4, fill gaps between rocks with planting soil to the maximum depth possible prior to planting on top.

3. Emergent bench shall be sloped approx 10% to river and shall vary in elevation ± foot along entire length to provide an uneven surface.



TYPICAL CROSS SECTION

NTS

Typical Planting Schedule - DWR Levee Repair

Zone	Elevation above 0ft	Botanical Name	Common Name	Propagation Method	Size	Group	Spacing/Rate/Method
1 (emergent bench)		Scirpus acutus	common tule	Container	Tree Band or larger	1	1 Plant from Group 1 at 1.5 ft. O.C.
		Scirpus californicus	California bulrush	Container	Tree Band or larger	1	
		Scirpus spp. (includes S. acutus and/or S. californicus)	bulrush/tule species	transplant	3 foot diameter clumps	NA	Clumps transplanted from borrow/donor sites - 10 ft. O.C.
2 (transition slope)		Salix spp. (includes S. exigua, S. lasiolepis, S. gooddingii, S. lucida, S. exigua)	willow species	pole cuttings	3 - 5 ft length 0.75 - 3.5 inch Diameter	NA	Fascine Bundles - 4 to 6 inch diameter, 1 bundle per 3 linear feet imbedded into riprap slope face at multiple elevations
3 (riparian bench)		Leymus triticoides	creeping wildrye	Division	Tree Band or larger	NA	1.5 ft. O.C.
		Grindelia camporum	gum plant	Container	1 gallon	2	1 Plant from Group 2 at 5 ft. O.C.
		Deschampsia cespitosa	tufted hair-grass	Container	1 gallon	2	
		Acer negundo	box elder	Container	5 gallon	3	
		Salix spp. (includes S. exigua, S. lasiolepis, S. gooddingii, S. lucida, S. exigua)	willow species	pole cuttings	3 - 5 ft length 0.75 - 3.5 inch Diameter	NA	Live brush mat (see drawing detail)
		Achillea millefolium	common yarrow	Seed	NA	NA	Hand broadcast seed at 4 lbs/ac
		Hordeum brachyantherum	meadow barley	Seed	NA	NA	Hand broadcast seed at 10 lbs/ac
		Artemisia douglasiana	mugwort	Seed	NA	NA	Hand broadcast seed at [illegible] lbs/ac
4 (levee slope)		Rhamnus californica	California coffeeberry	Container	1 gallon	4	1 Plant from Group 4 at [illegible] ft. O.C.
		Rosa californica	California rose	Container	1 gallon	4	
		Rubus ursinus	California blackberry	Container	1 gallon	4	
		Baccharis pilularis	coyote brush	Container	1 gallon	4	
		Populus fremontii	Fremont's cottonwood	Container	5 gallon	5	1 Plant from Group 5 at 18 ft. O.C. Plant at lower portion of planting zone
		Acer negundo	box elder	Container	5 gallon	5	
		Alnus rhombifolia	white alder	Container	5 gallon	5	
		Quercus lobata	Valley oak	Container	5 gallon	6	1 Plant from Group 6 at 18 ft. O.C. Plant at higher portion of planting zone
		Platanus racemosa	sycamore	Container	5 gallon	6	
		Bromus carinatus	California brome	Seed	NA	NA	10 lbs/ac
		Elymus glaucus	blue wild rye	Seed	NA	NA	8 lbs/ac
		Nassella pulchra	purple needle grass	Seed	NA	NA	5 lbs/ac
		Melica californica	California melic	Seed	NA	NA	5 lbs/ac
		Achillea millefolium	Common yarrow	Seed	NA	NA	4 lbs/ac
		Aster chilensis	Common aster	Seed	NA	NA	4 lbs/ac
		Bromus carinatus	California brome	Seed	NA	NA	8 lbs/ac
		Eschscholzia californica	California poppy	Seed	NA	NA	4 lbs/ac
		Hordeum brachyantherum	meadow barley	Seed	NA	NA	4 lbs/ac
		Lupinus bicolor	miniature lupine	Seed	NA	NA	8 lbs/ac

NA = Not Applicable

REV	DATE	DESCRIPTION	ENG.	APPR.

DESIGNED W. ZIRJACKS | REVIEWED | DATE MAY 01, 2006
DRAWN L.D. BERNALDEZ | APPROVAL RECOMMENDED
CHECKED | APPROVED PROJECT MANAGER

STATE OF CALIFORNIA
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DIVISION OF ENGINEERING
FLOOD MANAGEMENT

SACRAMENTO RIVER FLOOD CONTROL PROJECT
EMERGENCY LEVEE EROSION REPAIR
SITE SAC 56.8R TYPICAL SECTION

SPEC NO.
DRAWING NO. C-05
REV | SHEET NO. 005

May 05, 2006 - 4:47pm
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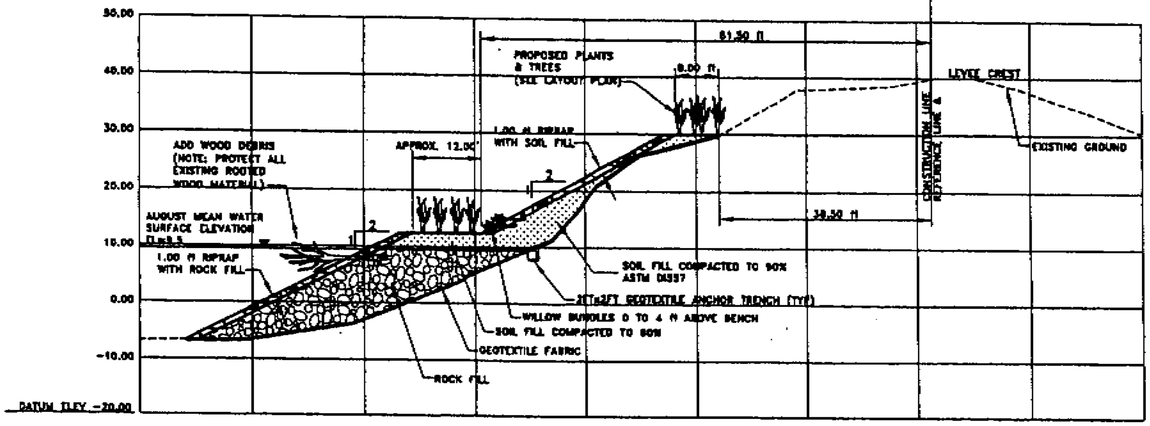
Typical Cross Section at Sacramento River, RM 56.8



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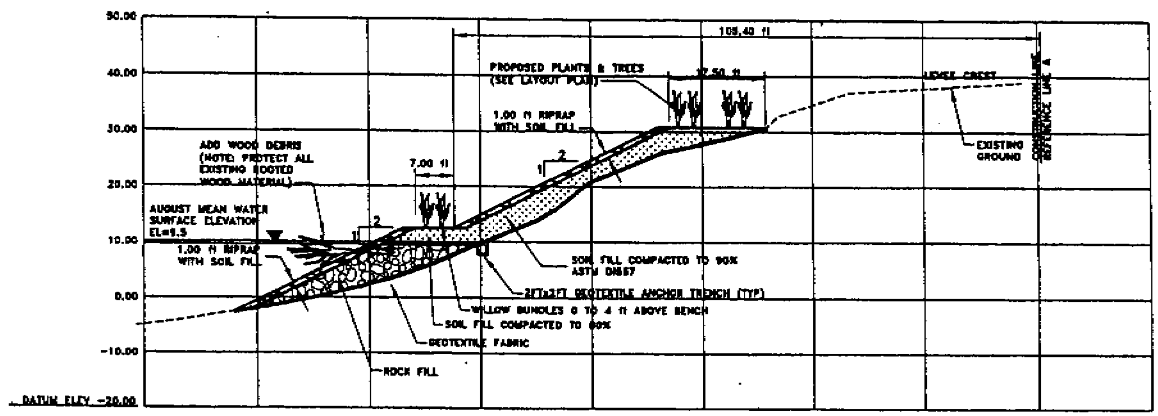

SECTION-2 - STA 17+90.00 - STA 21+37.85 (TYP)

1:10

URS

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FLOOD MANAGEMENT

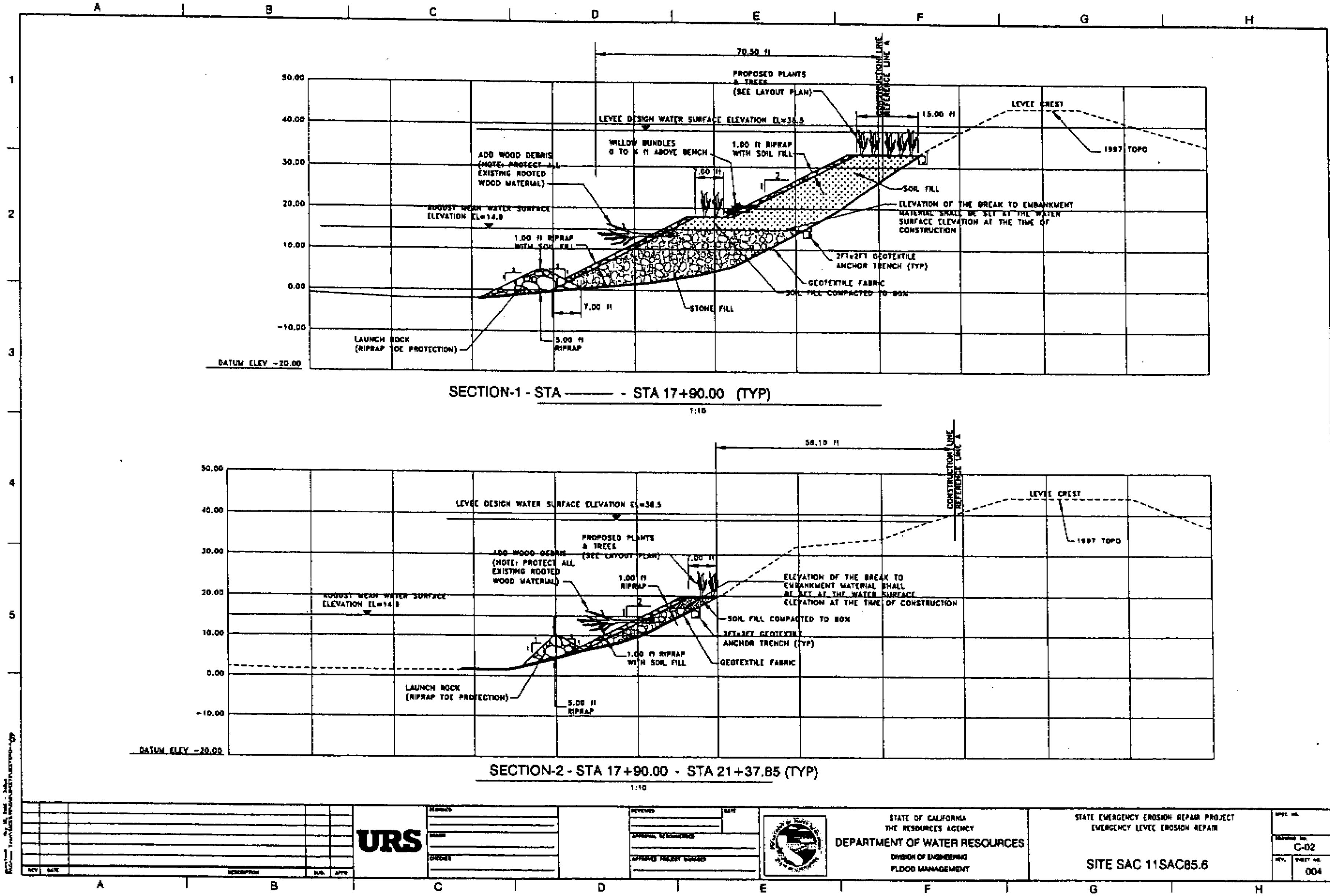
STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR

SITE SAC 9SAC69.9

C-02

004

Typical Cross Section at Sacramento River, RM 69.9



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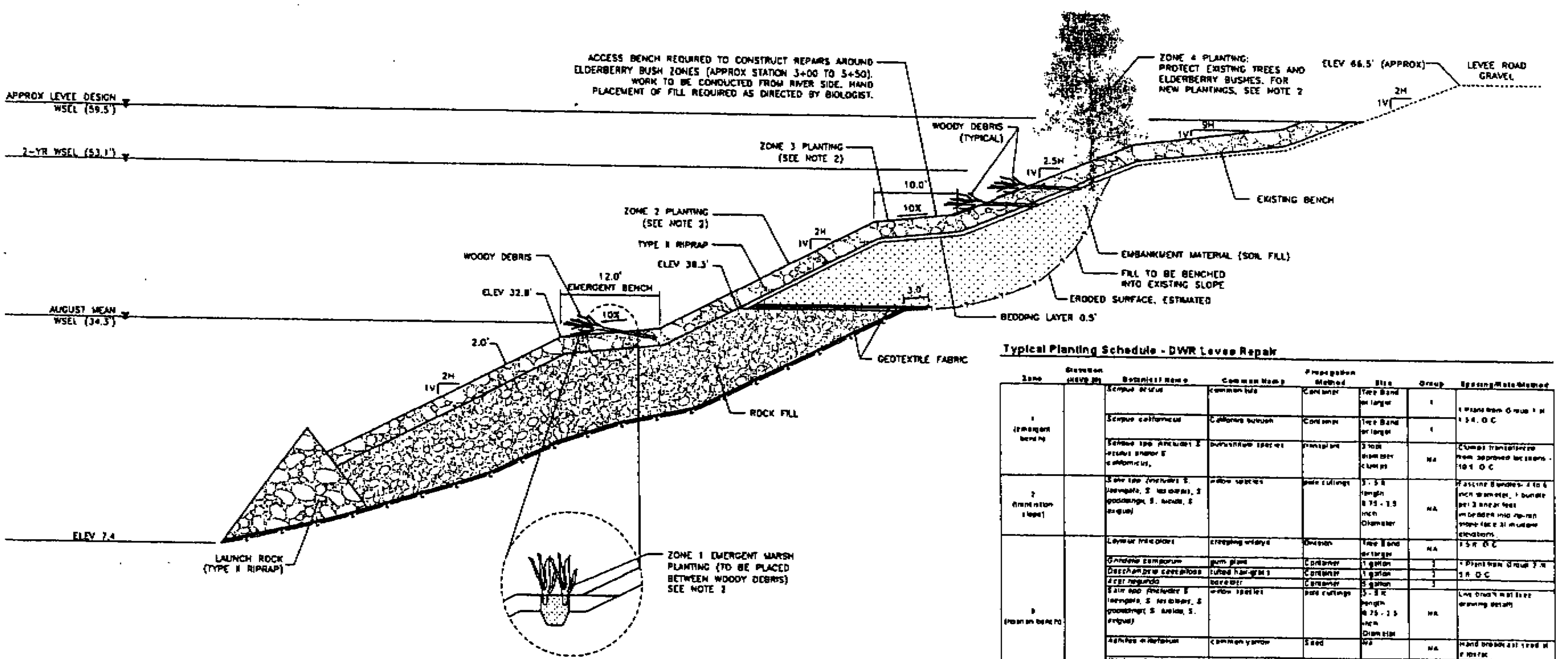

TYPICAL CROSS SECTION

NTS

NOTES:

1. Emergent bench shall be sloped approx 10% to river and shall vary in elevation & foot along entire length to provide an uneven surface.

2. Four different zones of plantings are used at this site. The zones are shown in the typical cross section, and the species to be planted and their spacing are shown in the table at the left. See also Specification Section 2950.

3. After placement of rock fill in Zone 2 and riprap in Zone 4, fill gaps between rocks with planting soil to the maximum depth possible prior to planting on top.

Typical Planting Schedule - DWR Levee Repair

Zone	Elevation (NAVD 88)	Botanical Name	Common Name	Propagation Method	Size	Group	Spacing/Rate/Method
1 (emergent bench)		Scirpus acutus	common tule	Container	Tree Band or larger	1	1 Plant from Group 1 at 1.5 ft. O.C.
		Scirpus californicus	California bulrush	Container	Tree Band or larger	1	
		Scirpus spp. (includes S. acutus and/or S. californicus)	bulrush/tule species	Transplant	3 foot diameter clumps	NA	Clumps transplanted from approved locations - 10 ft. O.C.
2 (transition slope)		Salix spp. (includes S. laevigata, S. lasiolepis, S. goodingii, S. lucida, S. exigua)	willow species	pole cuttings	3 - 5 ft length 0.75 - 1.5 inch Diameter	NA	Fascine Bundles: 4 to 6 inch diameter, 1 bundle per 3 linear feet imbedded into rip-rap slope face at multiple elevations.
3 (riparian bench)		Leymus triticoides	creeping wildrye	Division	Tree Band or larger	NA	1.5 ft. O.C.
		Grindelia camporum	gum plant	Container	1 gallon	3	1 Plant from Group 3 at 5 ft. O.C.
		Deschampsia caespitosa	tufted hair-grass	Container	1 gallon	3	
		Acer negundo	box elder	Container	5 gallon	3	
		Salix spp. (includes S. laevigata, S. lasiolepis, S. goodingii, S. lucida, S. exigua)	willow species	pole cuttings	3 - 5 ft length 0.75 - 1.5 inch Diameter	NA	Live brush mat (see drawing detail)
		Achillea millefolium	common yarrow	Seed	NA	NA	Hand broadcast seed at [illegible] lbs/ac
		Hordeum brachyantherum	meadow barley	Seed	NA	NA	Hand broadcast seed at 10 lbs/ac
		Artemisia douglasiana	mugwort	Seed	NA	NA	Hand broadcast seed at 6 lbs/ac
4 (levee slope and bench)		Rhamnus californica	California coffeeberry	Container	1 gallon	4	1 Plant from Group 4 at 5 ft. O.C.
		Rosa californica	California rose	Container	1 gallon	4	
		Rubus ursinus	California blackberry	Container	1 gallon	4	
		Baccharis pilularis	coyote brush	Container	1 gallon	4	
		Populus fremontii	Fremont's cottonwood	Container	5 gallon	5	1 Plant from Group 5 at 18 ft. O.C. Plant at lower portion of planting zone
		Acer negundo	box elder	Container	5 gallon	5	
		Alnus rhombifolia	white alder	Container	5 gallon	5	
		Quercus lobata	Valley oak	Container	5 gallon	6	1 Plant from Group 6 at 18 ft. O.C. Plant at higher portion of planting zone
		Platanus racemosa	sycamore	Container	5 gallon	6	
		Bromus carinatus	California brome	Seed	NA	NA	10 lbs/ac
		Elymus glaucus	blue wild rye	Seed	NA	NA	6 lbs/ac
		Nassella pulchra	purple needle grass	Seed	NA	NA	4 lbs/ac
		Melica californica	California barley	Seed	NA	NA	3 lbs/ac
		Achillea millefolium	Common yarrow	Seed	NA	NA	4 lbs/ac
		Aster chilensis	Common aster	Seed	NA	NA	4 lbs/ac
		Bromus carinatus	California brome	Seed	NA	NA	1 lbs/ac
		Eschscholzia californica	California poppy	Seed	NA	NA	4 lbs/ac
		Hordeum brachyantherum	meadow barley	Seed	NA	NA	4 lbs/ac
		Lupinus bicolor	miniature lupine	Seed	NA	NA	8 lbs/ac

NA = Not Applicable

DESIGNED: M.S. BURNETT	REVIEWED:	DATE: MAY 01, 2006
DRAWN: L.O. BERNALDEZ		
CHECKED:	APPROVED PROJECT MANAGER	

STATE OF CALIFORNIA
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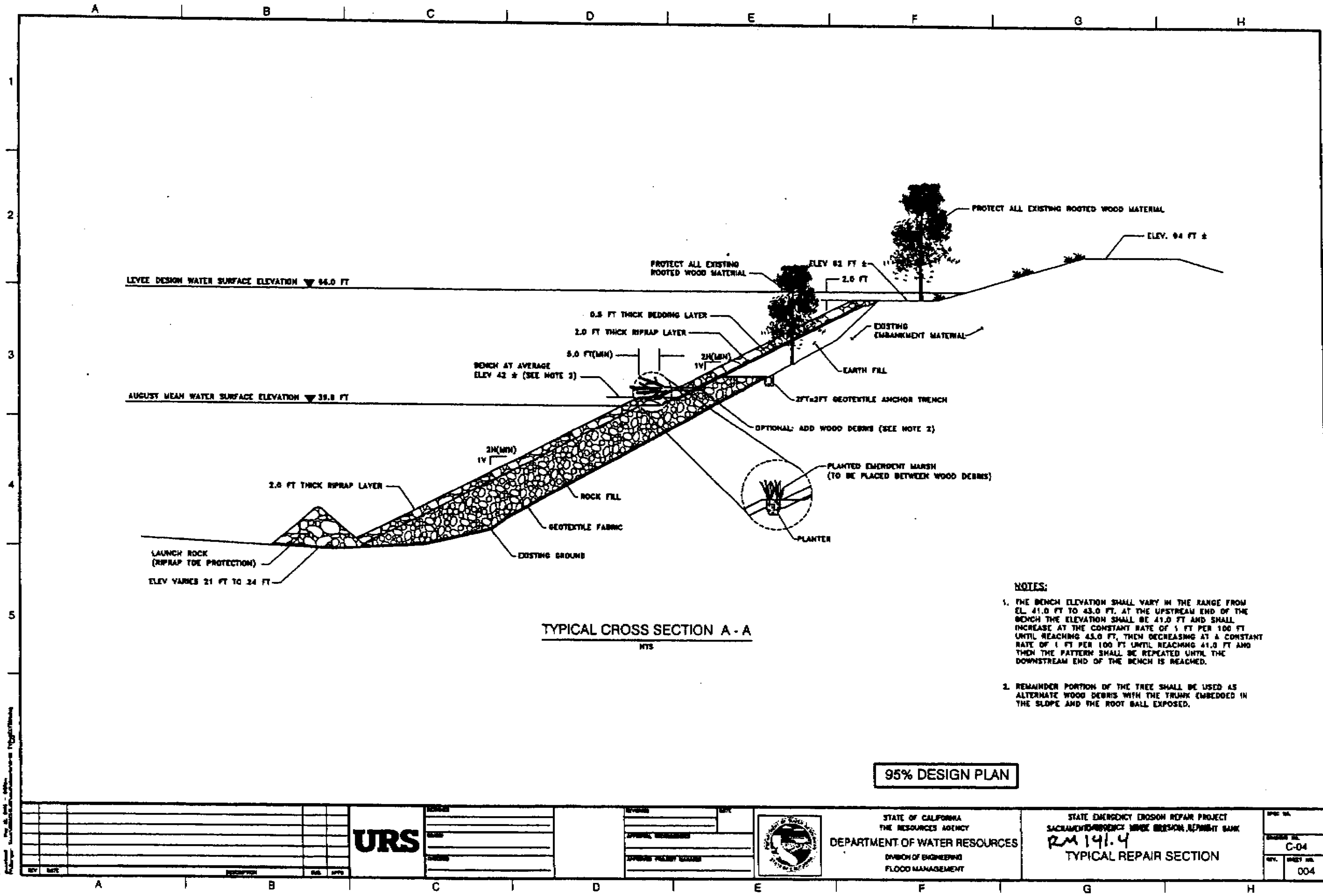
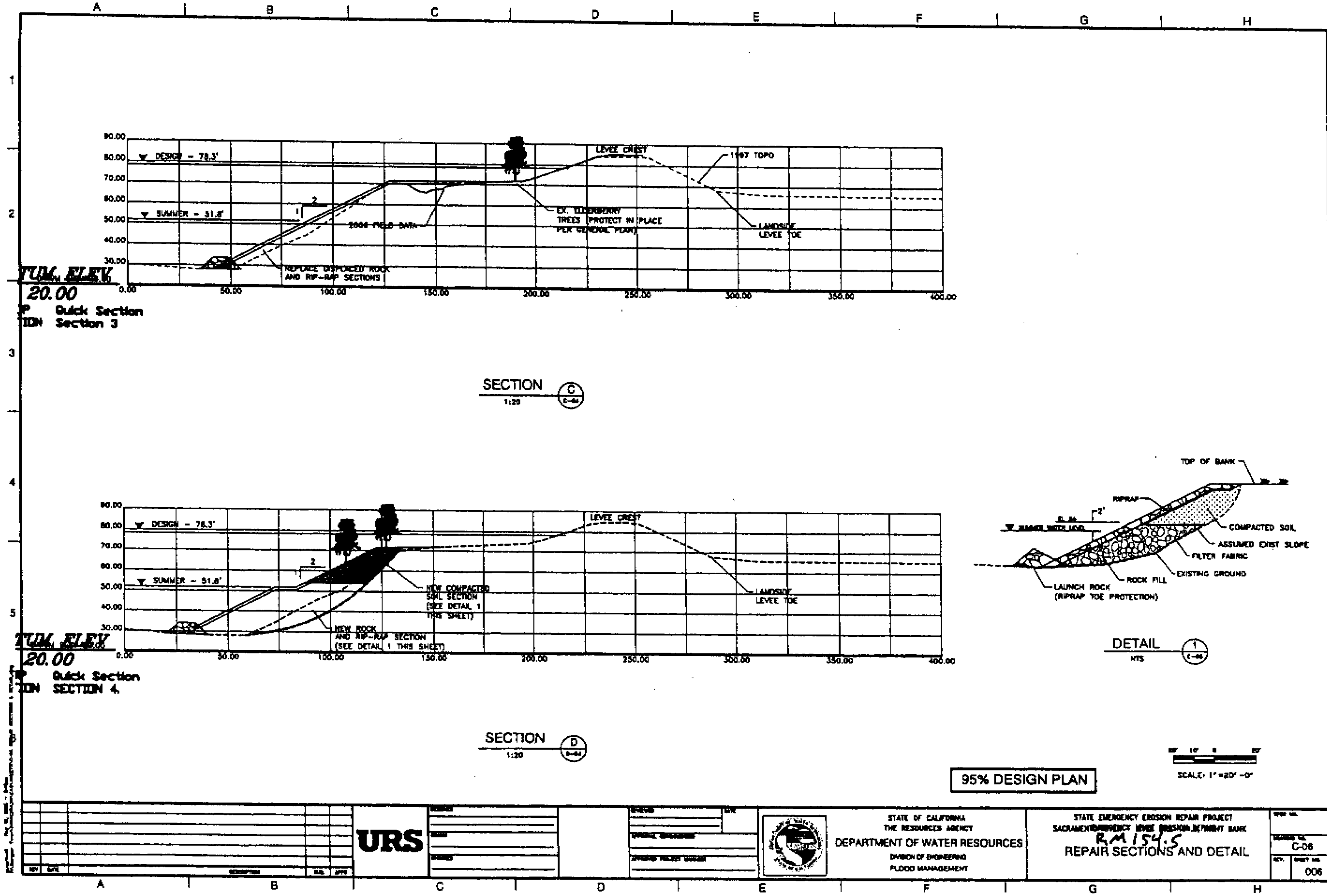
SACRAMENTO RIVER FLOOD CONTROL PROJECT
EMERGENCY LEVEE EROSION REPAIR
SITE SAC 130.8R TYPICAL SECTION

SPEC NO.
DRAWING NO. C-05
REV. SHEET NO. 005

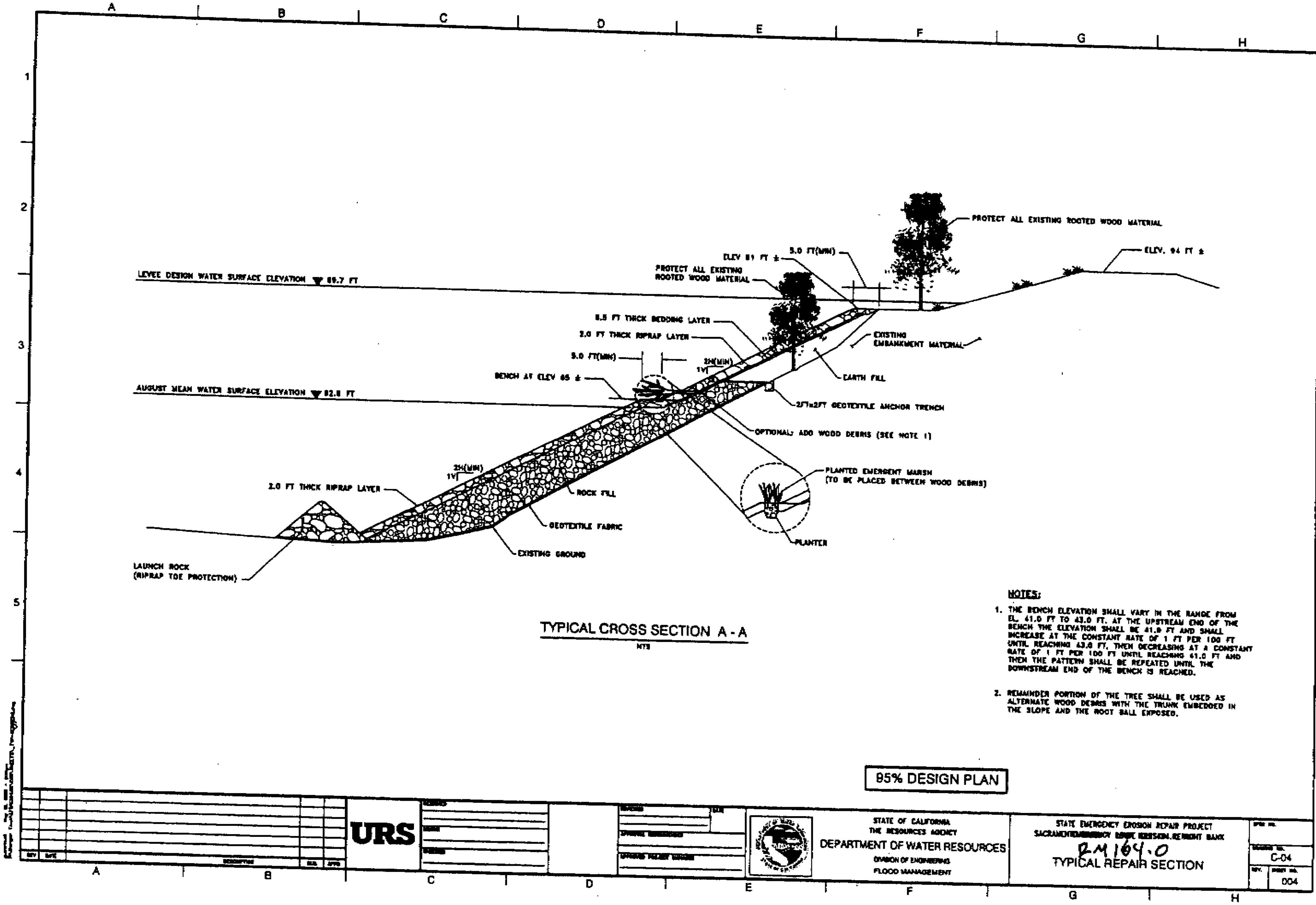
Typical Cross Section at Sacramento River, RM 130.8



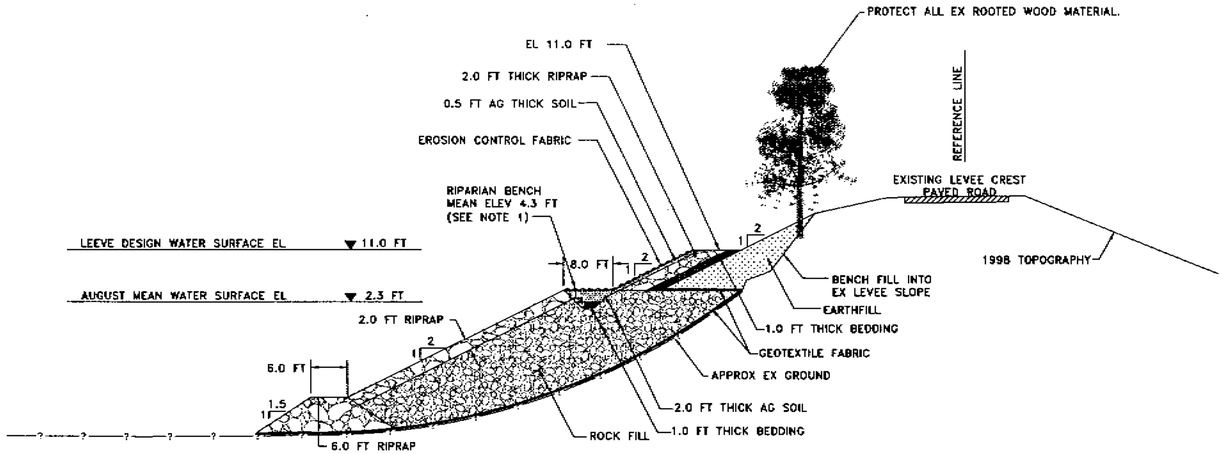
Typical Cross Section at Sacramento River, RM 141.4



Typical Cross Section at Sacramento River, RM 154.5

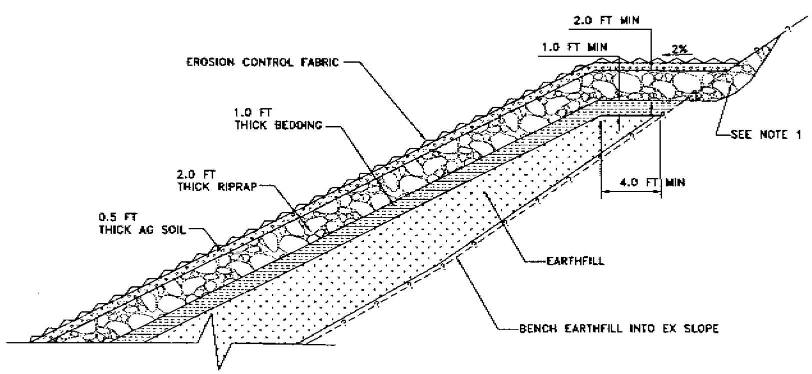


Typical Cross Section at Sacramento River, RM 164



TYPICAL CROSS SECTION

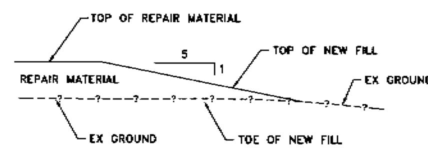
1"=10'



TRANSITION DETAIL (ABOVE WATER LEVEL)

NTS

(SEE DWG C-09)



TRANSITION PROFILE

NTS

NOTES:

1. THE FINISHED ELEVATION OF THE TOP ELEVATION OF RIPARIAN BENCH SHALL BE VARIED BY +/- 1 FOOT FROM SPECIFIED MEAN ELEVATION IN 40-FOOT TO 80-FOOT-LONG IRREGULAR UNDULATIONS.
2. GAPS IN ROCK FILL UNDER RIPARIAN BENCH AND IN RIPRAP ON UPPER LEVEE SLOPE SHALL BE FILLED WITH AGRICULTURAL SOIL TO MAXIMUM EXTENT AND DEPTH PRACTICAL BEFORE PLACING OVERLYING AGRICULTURAL SOIL.
3. AGRICULTURAL SOIL SURFACES SHALL BE PROTECTED FROM EROSION BY PLACING EROSION CONTROL FABRIC ON SURFACES.

95% DESIGN PLAN

SCALE: 1"=10'

DESIGNED S. PUNYAMURTHULA
DRAWN M. SAVANNAH
CHECKED M. FORREST REG. NO. C-27855
APPROVAL RECOMMENDED U. LUSCHER REG. NO. CE-17851
APPROVAL BY S. SALAH-MARS REG. NO. CE-50445
URS
REVIEWED REG. CE. NO. 62487
APPROVAL RECOMMENDED REG. CE. NO. 30612
APPROVED PROJECT MANAGER REG. CE. NO. 29388

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FLOOD MANAGEMENT

STATE EMERGENCY EROSION REPAIR PROJECT
EMERGENCY LEVEE EROSION REPAIR
CACHE SLOUGH-MILE 16.5L & 21.8R, STEAMBOAT SLOUGH-MILE 16.2R, AND SACRAMENTO RIVER-MILE 20.8L, 26.5L & 32.5R
STEAMBOAT SLOUGH-MILE 16.2, RIGHT BANK
TYPICAL SECTION

DRAWING NO. C-10
SHEET NO. 014

Typical Cross Section at Steamboat Slough RM 16.2

Attachment B
Pocket Area SAM Report

Habitat Evaluation of the Pocket Bank Protection Sites, Sacramento River, Using the Standard Assessment Method

Prepared for:

Sacramento Area Flood Control Agency
1007 7th Street, 7th Floor
Sacramento, CA 95814
Contact: Peter Buck
916/874-7606

Prepared by:

Jones & Stokes
2600 V Street
Sacramento, CA 95818-1914
Contact: Bill Mitchell
916/737-3000

April 2006

Jones & Stokes. 2006. Habitat Evaluation of the Pocket Bank Protection Sites, Sacramento River, Using the Standard Assessment Method. April. (J&S 04423.04.) Sacramento, CA.

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  Wetted Areas 5
  Shoreline Length 5
  Bank Slope 5
  Floodplain Inundation Ratio 6
  Bank Substrate Size 6
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Results 7
  Chinook Salmon 8
  Steelhead 8
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Conclusions 9
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Appendix A. Design Objectives for Bank Protection

Appendix B. Memorandum to NOAA Fisheries and the U.S. Fish and Wildlife Service on SAM Modifications and Refinements

Appendix C. SAM Input Data

Tables and Figures

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2	Steelhead Weighted Response Indices for Pocket Bank Protection Sites	7
3	Delta Smelt Weighted Response Indices for Pocket Bank Protection Sites	7

Acronyms and Abbreviations

Corps	U.S. Army Corps of Engineers
D50	median particle diameter of the bank
IWG	Interagency Working Group
IWM	of instream woody material
NGVD	national geodetic vertical datum
NOAA Fisheries	National Marine Fisheries Service
Q2	2-year flood event
SAFCA	Sacramento Area Flood Control Agency
SAM	Standard Assessment Methodology
SRA	shaded riverine aquatic
SRBPP	Sacramento River Bank Protection Project
WRI	weighted response index

Habitat Evaluation of the Pocket Bank Protection Sites, Sacramento River, Using the Standard Assessment Method

Introduction

The U.S. Army Corps of Engineers (Corps) and State Reclamation Board propose to implement levee erosion protection under the Sacramento River Bank Protection Project (SRBPP) at eight eroding sites on the left bank levee of the Sacramento River, designated RM 49.6, RM 49.9, RM 50.2, RM 50.4, RM 50.8, RM 51.5, RM 52.4, and RM 53.1, hereafter referred to as the Pocket bank protection sites. Four of the eight eroding sites are considered critical and included among the 24 critical sites in Governor Schwarzenegger's February 24, 2006, Declaration of State of Emergency of California Levee Systems. Two of the sites are designated Federal Emergency Management Agency critical for certification of a 100-year floodplain, and two are considered potentially critical.

The purpose of this action is to ensure the reliability of the levees for the life of the project while protecting environmental values and compensating for and/or mitigating effects on environmental resources to the degree feasible. The completion of these bank protection measures along with several other Corps efforts in the Pocket Area will meet requirements necessary for certain areas of the Sacramento region to achieve Federal Emergency Management Agency certification of levees protecting south Sacramento along the Sacramento River. The project history, regulatory actions, and detailed project description can be found in the biological assessment for the Pocket bank protection sites (Jones & Stokes 2006).

The final project design is the result of a collaborative effort of the Interagency Working Group (IWG) whose primary goals are to identify, evaluate, design, and endorse conservation measures that are consistent with the non-jeopardy biological opinions for the SRBPP contracts 42E and 42F (National Marine Fisheries Service 2001; U.S. Fish and Wildlife Service 2001, 2004). Member agencies of the IWG participated in meetings and site visits with the Corps's project design team and Sacramento Area Flood Control Agency (SAFCA) staff throughout the conceptual design process.

The design objectives for the Pocket bank protection sites (Appendix A) include maximizing on-site mitigation credits concurrent with construction, achieving net gains in habitat values, and, to the extent feasible, restoring key attributes of natural shorelines to address the recovery needs of federally listed fish species. On-site compensation requires an innovative integration of engineering design with ecological objectives and fish habitat features at sites constrained by steep, eroding banks abutting urban levees. Although little potential exists to restore natural fluvial processes in this levee-confined portion of the lower Sacramento River, a number of habitat design objectives have been incorporated into the project to maximize the long-term effectiveness of the project in meeting the compensation needs for listed fish species and their critical habitat.

The development of the final project design and evaluation of its effectiveness in meeting the design objectives were accomplished by applying the Standard Assessment Methodology (SAM) during the project planning and evaluation stages. The SAM was developed by the Corps, in consultation with the IWG member agencies, to address the specific habitat assessment and regulatory requirements identified by the biological opinions for the SRBPP and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species (Stillwater Sciences and Dean Ryan Consultants & Designers 2004).

The following report describes the results of the SAM for the Pocket bank protection project, including the project's effectiveness in addressing the habitat compensation needs of the primary fish species and life stages of concern, as identified in the biological assessment. This assessment also represents an important opportunity to evaluate the SAM and several proposed modifications to the SAM model that were made to improve the resolution and accuracy of the SAM in quantifying the benefits of specific design features for which detailed topography, design drawings, and hydraulic data are available.

Based on the SAM results and other design considerations not specifically addressed by the SAM, it is concluded that the compensation and habitat design objectives of the project would be met. Overall, the project would effectively compensate for short-term losses and result in significant long-term gains in nearshore and shaded riverine aquatic (SRA) cover values. Long-term benefits to listed species include substantial increases in the amount of shallow water and instream cover available to juvenile Chinook salmon and steelhead during typical winter and spring flows. Net reductions in habitat values would occur in the fall, but the effects on listed species (primarily winter-run and spring-run Chinook salmon) are expected to be minor based on the timing and abundance of juvenile salmon and the availability of key habitat features as a function of flow in the project reach. The potential effects of the project on delta smelt cannot be defined clearly because of the lack of specific information on the spawning distribution and habitat preferences of this species. Based on the general relationship between delta smelt spawning success and shallow, low-velocity habitats with dense vegetation, it is likely that the project will increase the overall suitability of these sites for delta smelt spawning and incubation.

Standard Assessment Method

Overview

The SAM quantifies habitat values in terms of bank line– or area-weighted species responses that are calculated by combining habitat quality (fish response indices) with quantity (bank length or wetted area) for each season, target year, and relevant species/life stage. The SAM employs six habitat variables to characterize nearshore and floodplain habitats of listed fish species:

- bank slope—average bank slope along each average seasonal water surface elevation;
- floodplain availability—ratio of wetted channel and floodplain area during the 2-year flood to the wetted channel area during average winter and spring flows;
- bank substrate size—the median particle diameter of the bank (D50) along each average seasonal water surface elevation;
- instream structure—percent of shoreline occupied by instream woody material (IWM) along each average seasonal water surface elevation;
- aquatic vegetation—percent of shoreline occupied by aquatic or riparian vegetation along each average seasonal water surface elevation; and
- overhanging shade—percent of shoreline covered by shade along each average seasonal water surface elevation.

The fish response indices are derived from hypothesized relationships between key habitat variables and the responses of individual species and life stages. The response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (e.g., with or without project), the SAM uses the fish response relationships to determine the response of individual species and life stages to changes in the habitat variables for each season and target year. The response indices for each variable are multiplied together to generate an overall species response index, which is then multiplied by the area or linear feet of bank to which it applies to generate a weighted species response index (expressed as feet or square feet). The weighted response index (WRI) provides a common metric that can be used to quantify habitat values over time, compare project alternatives to existing conditions, and evaluate the effectiveness of on-site and off-site mitigation actions. For example, the difference in WRIs between with- and without-project conditions in a given year and season provides a measure of the impacts (negative species response) or benefits (positive species response) of the project relative to baseline conditions (relative WRI).

Following a recent review and evaluation of the SAM, Jones & Stokes proposed several modifications to improve the resolution and accuracy of the SAM in quantifying the benefits of specific bank protection design features for which detailed topography, design drawings, and hydraulic data are available. Jones &

Stokes and MIG (on behalf of the Sacramento Area Flood Control Agency), National Marine Fisheries Service (NOAA Fisheries), and U.S. Fish and Wildlife Service met informally on May 17 and August 1, 2005, to discuss these modifications. A second meeting on August 30, 2005, was held to present the recommendations and seek concurrence from members of the IWG and other agencies and consultants involved in projects of the SRBPP and River Mile 56.7 project design team.

In summary, the proposed modifications include:

- eliminating the response of delta smelt juveniles and adults to changes in nearshore cover based on the pelagic nature of these life stages and their reduced dependence on nearshore cover;
- applying the habitat response curves for delta smelt spawning and incubation life stages to newly hatched larvae based on the importance of nearshore habitat to these life stages;
- characterizing the quality of shallow water habitat based on the slope of the submerged portion of the bank rather than the slope of the bank at the water's edge;
- quantifying floodplain habitat values based on the actual area of inundated floodplain rather than the ratio of floodplain-to-channel inundation area; and
- quantifying shoreline habitat variables (IWM, aquatic vegetation, shade) based on the actual length of the existing or created shoreline (wetted shoreline contour of bank at different flows).

The meeting participants expressed general support for the proposed modifications to the SAM. Several questions or concerns remained regarding details of the computational procedures used to quantify or weight specific SAM variables. The proposed modifications, along with clarifications to address the comments received on August 30, 2005, were presented in an October 24, 2005, memorandum to NOAA Fisheries and the U.S. Fish and Wildlife Service (Appendix B). The meeting participants agreed to a trial period in which the SAM and the proposed modifications would be used to evaluate the mitigation requirements for ongoing and proposed bank protection projects in the Pocket Area and other Sacramento River sites.

Methods

The SAM was used to quantify the responses of listed fish species to with-project conditions over a 50-year project period and compare these responses to the species responses under without-project (existing) conditions. The assessment followed the general steps outlined in the SAM Final Review Draft and Users Manual (Stillwater Sciences and Dean Ryan Consultants & Designers 2004, 2006). Computations were performed using the Electronic Calculation Template (Microsoft Access application) provided by Stillwater Sciences.

Tables C-1 through C-24 in Appendix C summarize the SAM input data used to characterize existing and with-project conditions at each site. The data collection methods, sources, and modifications to the SAM assessment procedures are summarized below for each variable.

Shoreline Elevations

The Corps estimated average fall, winter, spring, and summer water surface elevations (seasonal shoreline elevations) for the project site from daily flow data measured in the Sacramento River at Freeport for the period 1968–2002 and daily flow and stage data measured in the Sacramento River at I Street for the period 1987–2002.

Wetted Areas

Wetted surface areas of the river (measured from the centerline of the river) were obtained by measuring the average width of the river from aerial photographs of the project sites. Based on the project description, no significant changes in wetted width of the river are expected under with-project conditions.

Shoreline Length

Shoreline lengths for each project site were obtained from site descriptions provided by the Corps. Shoreline length is defined as the total length of shoreline (defined by the water's edge or corresponding contour line) corresponding to each average seasonal flow. Variations in average river stage during each season may result in differing shoreline lengths at the same site. Based on the project description, no significant changes in seasonal shoreline lengths are expected under with-project conditions.

Bank Slope

In the SAM, bank slope serves as an indicator of the availability of shallow-water habitat and is obtained from point estimates of bank slope (horizontal change to vertical change) along each seasonal shoreline (i.e., line where the average water surface elevation contacts the bank). Bank slopes corresponding to each seasonal shoreline were obtained for existing and with-project conditions by averaging the slopes from a series of cross sections representing existing bank and 90% design contours. As recommended, average bank slope below the water line corresponding to each average seasonal flow was used to characterize shallow-water habitat. For the purposes of this assessment, the bank slope extending from each seasonal shoreline to a depth of 3 feet was used to define the limits of shallow water habitat.

Floodplain Inundation Ratio

In the SAM, floodplain habitat is defined by areas that are flooded by the 2-year flood event (Q2) and measured by dividing the wetted channel and floodplain area during the 2-year flood event by the wetted channel area during average winter and spring flows. Although modifications have been suggested to improve the way the SAM characterizes floodplain habitat, these modifications were unnecessary for the Pocket bank protection sites because no changes in floodplain habitat are proposed. This variable was set to 1.0 for both existing and with-project conditions to reflect no project effect.

Bank Substrate Size

Bank substrate size was measured as the median particle size (D50 in inches) within the submerged portion of the bank immediately below (0–3 feet) the average seasonal water surface elevation. A value of 0.01 inch was used to characterize fine sediment, and a value of 10 inches was used to characterize rock revetment, the two dominant substrate types under existing and with-project conditions. A substrate size of 0.01 inch was assumed for with-project conditions during winter and spring flows because fine sediment would be incorporated into the rock revetment above 5 feet national geodetic vertical datum (NGVD) and a 1-foot layer of fine sediment would be placed on top of the rock revetment surface above 5 feet NGVD. A value of 10 inches was assumed for summer and fall flows because little deposition is expected at or below 5 feet NGVD.

Instream Structure

Instream structure is defined as IWM, excluding live bank vegetation, that is partially or fully submerged during average seasonal flows. This variable was measured by estimating the percent of shoreline that is occupied by IWM within the inundation zone associated with each average seasonal flow under existing and with-project conditions. Measurements of the linear extent of existing IWM along the summer-fall and winter-spring shorelines were taken from photographs (scaled based on the known vertical distance between the existing shoreline and the top of the levee or berm) of the project sites taken on November 14, 2005. With-project estimates were based on the assumption that 50% of the existing IWM would remain after construction. It was assumed that the remainder would be lost as a result of burial and damage by rock revetment during construction. These losses would be offset by adding IWM below the average fall water surface to achieve 40% cover during average fall flows. The addition of IWM along the fall shoreline is designed to maximize on-site habitat values for juvenile salmon during the fall when winter-run and spring-run juveniles may be present in the lower Sacramento River. It was assumed that the linear feet of IWM present after construction would not change significantly during the 50-year project period.

Aquatic Vegetation

Aquatic vegetation is defined as aquatic or live riparian vegetation that is partially or fully submerged during average seasonal flows. This variable was measured by estimating the percent of shoreline that is occupied by vegetation within the inundation zone associated with each average seasonal flow under existing and with-project conditions. Measurements of the linear extent of existing vegetation along the summer-fall and winter-spring shoreline were taken from photographs (scaled based on the known vertical distance between the existing shoreline and the top of the levee or berm) of the project sites taken on November 14, 2005. With-project estimates of vegetative cover were based on the planting plans and observed growth rates and canopy widths of planted trees and shrubs on constructed banks. It was assumed that vegetative cover along the winter and spring shorelines would increase from 20% in year 1 to 75% by year 15.

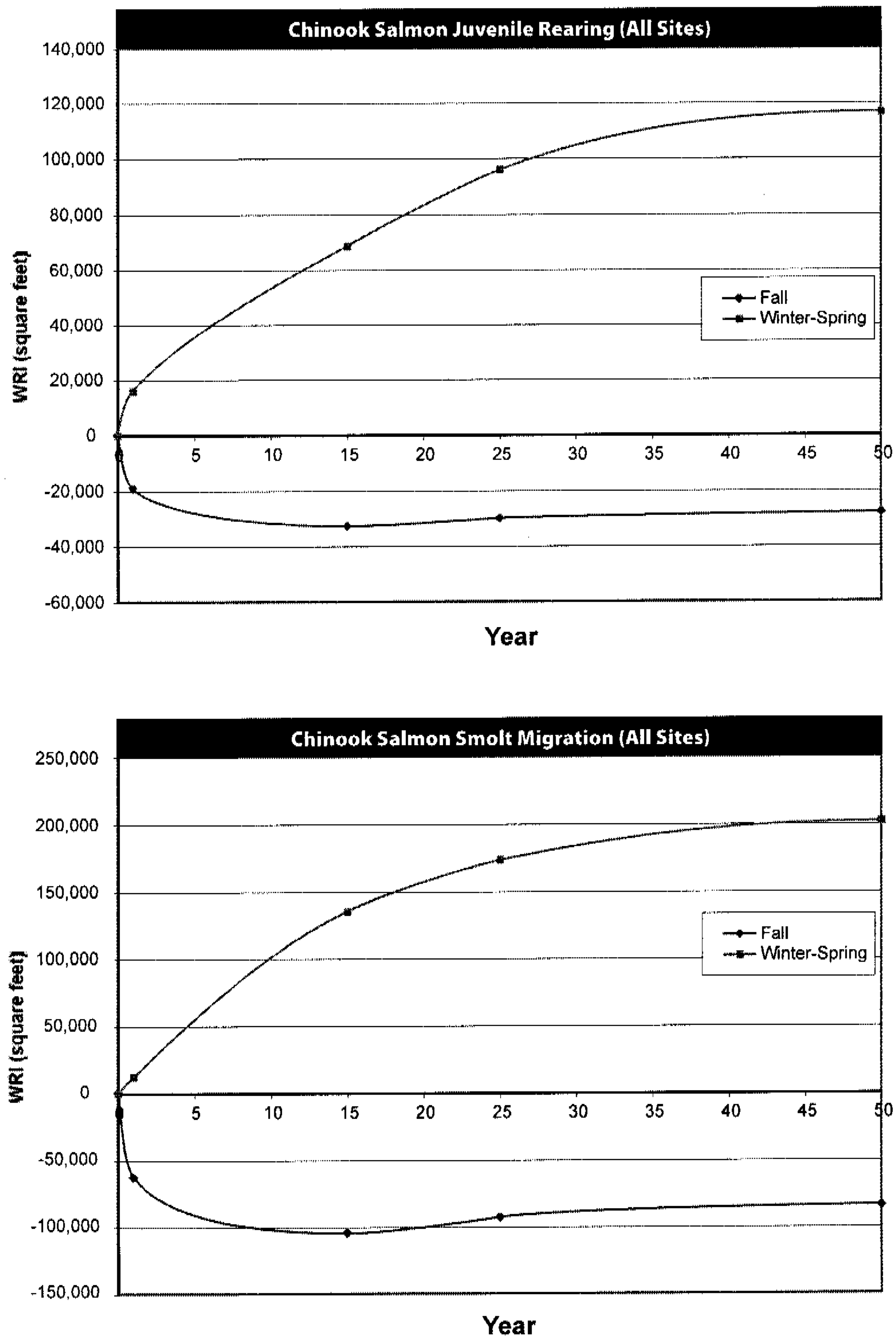
Shade

Shade was measured by estimating the percent of shoreline in which riparian vegetation extends over the water during average seasonal flows. Measurements of the linear extent of shade along the summer-fall and winter-spring shoreline were taken from photographs (scaled based on the known vertical distance between the existing shoreline and the top of the levee or berm) of the project sites taken on November 14, 2005. Based on the project description, it was assumed that all mature trees that currently shade the winter-spring shoreline would be maintained under with-project conditions. It was also assumed that the extent of shade over the winter and spring shoreline would increase in response to increasing vegetative cover but that shade cover would be limited to a smaller percentage of the total shoreline length because of expected gaps in the canopy. Expected increases in canopy widths of trees and shrubs on the bench constructed as part of the project would eventually result in shading of the summer-fall shoreline. Shade cover is expected to result in 50% shading of the winter-spring shoreline and 10% of the summer-fall shoreline by year 15.

Results

Figures 1, 2, and 3 present the results of the SAM assessment for Chinook salmon and steelhead juveniles and smolts, and delta smelt spawning adults, eggs, and larvae. The seasons identified reflect the primary periods of occurrence of these species and life stages in the project area:

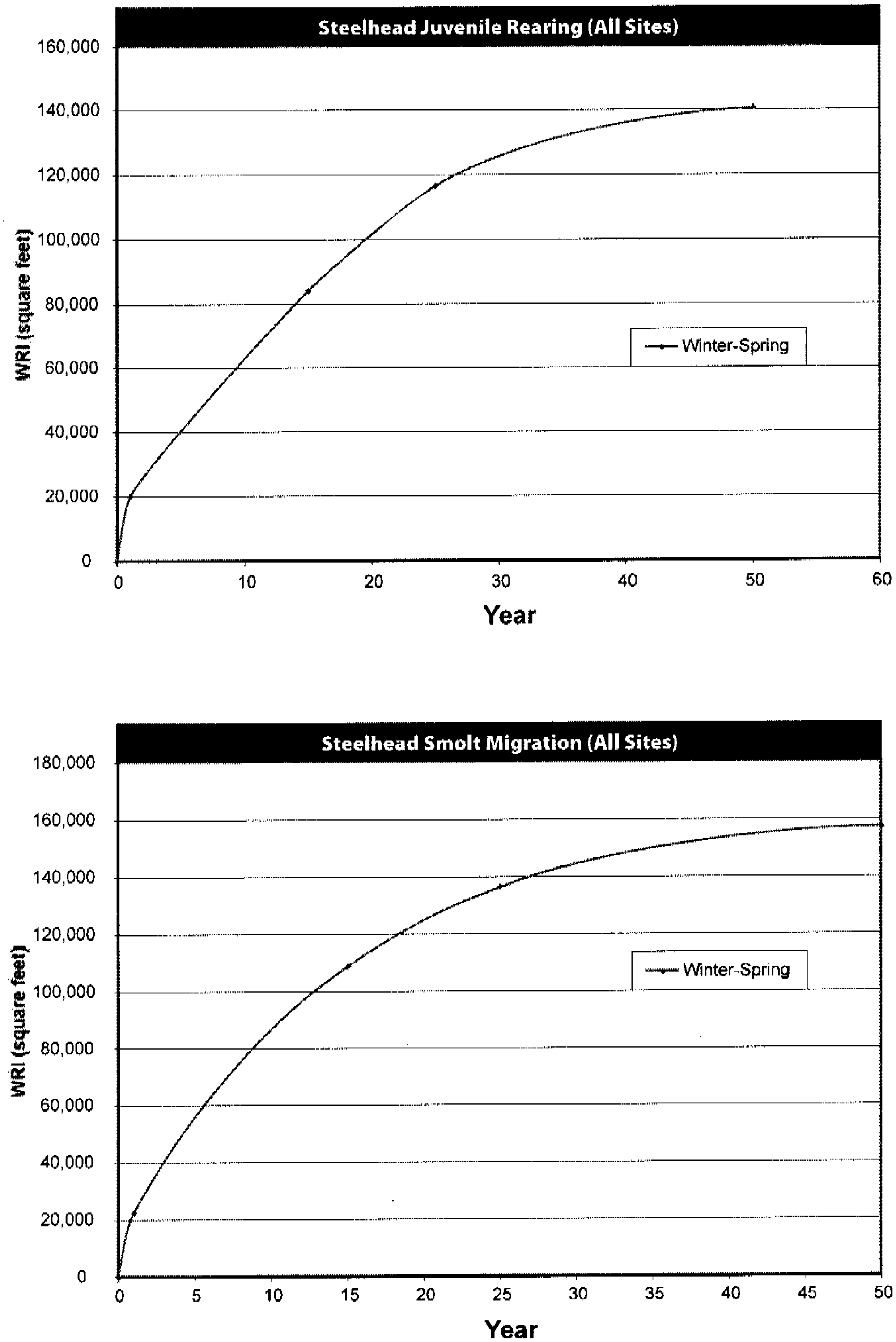
- fall-run Chinook salmon juveniles and smolts (winter, spring);
- late fall–run Chinook salmon juveniles and smolts (fall, winter);
- winter-run Chinook salmon juveniles and smolts (fall, winter, spring);
- spring-run Chinook salmon juveniles and smolts (fall, winter, spring);



03615.03 040

Jones & Stokes

Figure 1
Chinook Salmon Weighted Response Indices for Pocket Bank Protection Sites



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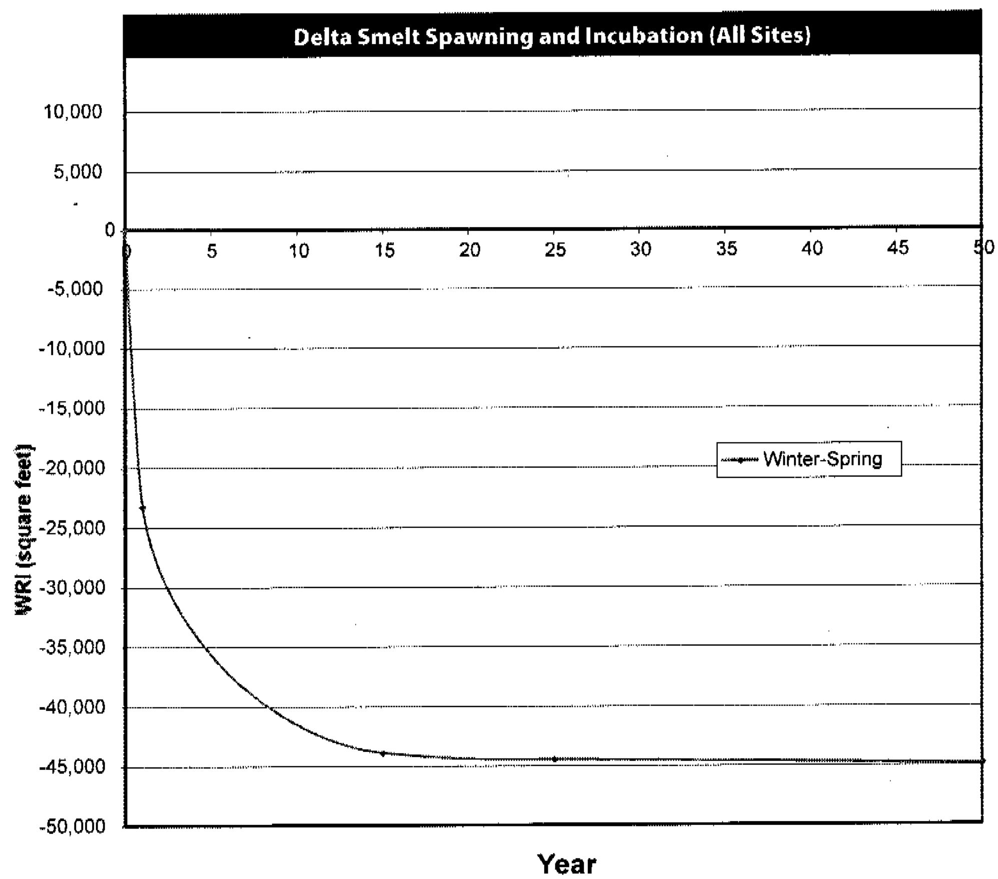
Jones & Stokes

Figure 2
Steelhead Weighted Response Indices for Pocket Bank Protection Sites



Jones & Stokes

Figure 3
Delta Smelt Weighted Response Indices for Pocket Bank Protection Sites

- steelhead juveniles and smolts (winter and spring); and
- delta smelt adults, eggs, and larvae (winter and spring).

The results, expressed in terms of relative WRIs, represent the seasonal responses of each species and life stage to with-project habitat conditions relative to existing conditions over the 50-year project period. Positive relative WRIs indicate net benefits or gains in habitat values relative to existing conditions, whereas negative relative WRIs indicate net deficits in habitat values relative to existing conditions.

Chinook Salmon

The SAM results indicate that the project would result in long-term gains in winter and spring habitat values and smaller long-term deficits in fall habitat values for juvenile Chinook salmon life stages (rearing and smolt migration) (Table 1, Figure 1). Long-term increases in Chinook salmon response indices primarily reflect the positive responses of juveniles to increases in the availability of shallow-water habitat, flooded vegetation, and IWM on the constructed bench during winter and spring flows.

Project construction would result in short-term losses of instream cover and shade associated with the loss of IWM and removal of vegetation along the winter-spring shoreline. However, these losses would be offset immediately or within several years by the creation of shallow-water habitat and the addition of IWM along the fall, winter, and spring shorelines in the first year of construction. Following construction, increases in the percent cover and shade provided by riparian vegetation on the constructed bench would result in further gains in winter and spring habitat values over the 50-year project period. Although the extent of IWM along the average fall shoreline would exceed pre-project levels, fall habitat values would not fully recover because of the permanent loss of shallow-water habitat and fine sediment along the fall shoreline.

Steelhead

The short- and long-term responses of steelhead juveniles and smolts to changes in winter-spring habitat conditions would be similar to those described above for Chinook salmon juveniles and smolts (Table 2, Figure 2). The differences in magnitude of the response indices between Chinook salmon and steelhead reflect differences in the species response curves for individual habitat variables.

Delta Smelt

At most sites, the SAM results indicated that the project would result in long-term gains in habitat values for delta smelt spawning and incubation life stages

Table 1. Chinook Salmon SAM Results for the Pocket Bank Protection Sites

Chinook	Year	WRI (square feet)								
		RM 49.6	RM 49.9	RM 50.2	RM 50.4	RM 50.8	RM 51.5	RM 52.4	RM 53.1	Total
Fall	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Juvenile	1	-1745.29	-1480.63	-8900.28	-413.74	-2780.70	-3770.45	-42.31	55.94	-19077.46
Rearing	15	-3097.19	-2594.24	-15732.54	-517.58	-4608.86	-6527.52	84.38	185.38	-32808.17
	25	-2922.11	-2419.08	-14790.14	-302.76	-4069.28	-6018.46	216.20	248.66	-30056.97
	50	-2790.79	-2287.71	-14083.34	-141.64	-3664.60	-5636.67	315.07	296.11	-27993.57
Winter	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring	1	-553.81	742.69	6620.27	3797.95	3576.14	-552.05	1755.62	545.13	15931.93
Juvenile	15	1594.05	3124.36	24274.12	9494.61	15573.72	7746.03	4960.27	2010.06	68777.22
Rearing	25	3482.06	4193.39	32161.48	11041.91	22041.22	14248.86	6125.33	2744.02	96038.25
	50	4898.06	4995.16	38077.00	12202.38	26891.84	19125.98	6999.13	3294.48	116484.03
Fall	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smolt	1	-5887	-4903.33	-29600.61	-1205.09	-8440.17	-12923.18	86.84	394.53	-62477.85
Migration	15	-10260	-8393.46	-51257.24	-1186.78	-13211.62	-21899.62	840.74	1075.45	-104292.15
	25	-9519	-7655.18	-47270.10	-304.48	-10951.87	-19776.09	1381.35	1336.12	-92759.55
	50	-8964	-7101.46	-44279.75	357.25	-9257.05	-18183.44	1786.80	1531.62	-84110.09
Winter	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring	1	-619.28	-734.88	5249.01	9770.18	1465.47	-7596.69	3396.46	1470.15	12400.42
Smolt	15	6379.91	4991.25	47246.71	25901.19	25885.04	8600.97	11060.41	5336.10	135401.59
Migration	25	8985.29	6441.17	57609.54	28094.00	35213.83	18056.64	12705.99	6520.47	173626.93
	50	10939.33	7528.61	65381.65	29738.60	42210.43	25148.38	13940.18	7408.74	202295.93

Table 2. Steelhead SAM Results for the Pocket Bank Protection Sites

		WRI (square feet)								
Steelhead	Year	RM 49.6	RM 49.9	RM 50.2	RM 50.4	RM 50.8	RM 51.5	RM 52.4	RM 53.1	Total
Winter	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring	1	-801.75	744.69	7780.03	4836.00	4878.65	-899.34	2504.06	836.66	19879.00
Juvenile	15	1651.29	3435.46	28655.62	11908.14	19944.52	8995.32	6727.97	2801.30	84119.62
Rearing	25	3874.80	4665.45	37815.91	13719.62	27689.48	16789.56	8117.83	3702.37	116375.01
	50	5542.44	5587.94	44686.13	15078.22	33498.19	22635.23	9160.22	4378.18	140566.56
Winter	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring	1	-117.44	578.70	8121.21	7874.88	3735.33	-2578.45	3442.53	1453.46	22510.23
Smolt	15	4280.36	4500.30	36371.02	19170.46	21354.62	9415.03	9350.81	4417.19	108859.78
Migration	25	6176.87	5473.01	43715.07	20741.01	28169.03	16339.54	10578.53	5298.79	136491.85
	50	7599.26	6202.54	49223.10	21918.93	33279.83	21532.93	11499.32	5960.00	157215.91

(adults, eggs, and larvae) (Table 3). These gains reflect the positive response of these life stages to increases in the availability of shallow water, flooded vegetation, and IWM on the constructed bench during winter and spring flows.

At most sites, no changes would occur in the dominant substrate type (fine sediment) during winter and spring flows. In contrast, project effects at RM 50.4 include replacing existing rock revetment (10-inch-diameter rock on the 2:1 slope) with fine sediment (0.01-inch-diameter sediment on the constructed bench), resulting in a long-term deficit in winter-spring habitat values that exceed the gains in habitat values at all other sites (Table 3, Figure 3). This result can be traced to the delta smelt spawning and incubation response relationship for bank substrate size, which assumes that survival of eggs and larvae drops rapidly to zero as substrate sizes decrease below 0.25 inch in diameter (D50) and that all substrates larger than or equal to 0.25 inch in diameter are optimal (see Figure H4.2 in the Final Review Draft of the SAM).

Conclusions

The results of the SAM assessment demonstrate the effectiveness of the proposed project design in minimizing impacts on listed species and their critical habitat and achieving project objectives relative to the needs of listed fish species. This design establishes an important precedent for future bank protection projects in the lower Sacramento River and other levee-confined reaches in the Central Valley where opportunities for reestablishing floodplain habitat and natural channel dynamics (bank erosion, channel migration, and riparian regeneration) have been eliminated or severely restricted.

The results also demonstrate that the SAM, with the recent modifications discussed earlier, provides sufficient resolution to accurately characterize the impacts and benefits of specific project features based on the needs of listed species as well as some of the broader ecological objectives that have been identified for the lower Sacramento River (e.g., restoring habitat diversity). The substantial positive responses of juvenile Chinook salmon and steelhead to with-project conditions reflect the significant habitat values associated with increased availability (area), accessibility (frequency of inundation), and complexity (shallow water, flooded vegetation, and IWM) of nearshore habitat along the winter-spring shoreline. These attributes also address the needs of other native fish species that use nearshore zones and floodplains for foraging, spawning, and early rearing in the winter and spring.

Other design elements not specifically addressed by the SAM but incorporated into the project design to address the needs of the target species and life stages include the use of structurally complex IWM at varying elevations to provide juvenile fish with refuge and escape cover from predators, swift currents, and boat wakes. Another important design feature is to gently slope the constructed bench toward the river to minimize the risk of fish stranding and promote sedimentation, natural plant establishment, and fish access to shallow water over a broad range of flows. Broader benefits of the project design include restoring

Table 3. Delta Smelt SAM Results for the Pocket Bank Protection Sites

		WRI (square feet)								
	Year	RM 49.6	RM 49.9	RM 50.2	RM 50.4	RM 50.8	RM 51.5	RM 52.4	RM 53.1	Total
Winter	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring	1	175.74	157.64	914.06	-25814.64	466.36	448.58	275.79	158.08	-23218.39
Spawning	15	405.51	368.48	2117.36	-49841.31	1083.78	1048.16	572.60	323.94	-43921.47
Incubation	25	416.90	379.18	2177.44	-50522.87	1114.78	1078.57	583.97	330.02	-44442.00
	50	425.44	387.21	2222.50	-51034.04	1138.04	1101.37	592.50	334.58	-44832.40

habitat diversity and native riparian vegetation and creating structural and hydraulic complexity needed to support other ecological functions characteristic of natural shorelines and floodplains (e.g., primary and secondary production, storage of sediment and organic material).

Long-term deficits in fall habitat values for juvenile Chinook salmon reflect the inability to fully compensate for losses of shallow-water habitat and natural substrates along the existing fall shoreline. Reductions in the availability of shallow-water habitat along the average fall shoreline are unavoidable given the proximity of the levee to the fall shoreline (which limits the lateral extent of constructed features) and the objective of maximizing the extent of shallow-water and SRA cover during winter and spring flows. The addition of IWM to achieve 40% coverage along the fall shoreline is designed to minimize these deficits and maximize on-site habitat values for juvenile salmon during the fall when winter- and spring-run juveniles may be present in the lower Sacramento River.

In evaluating the potential impacts associated with the fall habitat deficit, it is important to consider the timing and abundance of juvenile salmon and the availability of key habitat features as a function of flow in the project reach. The annual migration of juvenile Chinook salmon in the lower Sacramento River (composed initially of spring-run and winter-run Chinook salmon juveniles) does not begin until the first major flow increase of the season (Snider and Titus 2000), which typically occurs between mid-November and mid-December. Because these flows are often substantially higher than flows earlier in the season and coincide with cooler water temperatures, most juvenile Chinook salmon occur in the project area when flows have exceeded the fall average (approximately 15,000 cfs) and stage is sufficient (>4 feet) for fish to use at least a portion of the instream cover and shallow water on the constructed bench.

The potential effects of the project on delta smelt cannot be clearly defined because of the lack of specific information on the spawning distribution and habitat preferences of this species, particularly in the vicinity of Sacramento, which approaches the upstream limit of tidal influence on the lower Sacramento River. The SAM results for RM 50.4 indicate that the addition of fine sediment to existing rock revetment can have an overriding negative effect on the suitability of a site for delta smelt spawning and incubation. If so, most of the Pocket sites can be considered unsuitable for delta smelt spawning and incubation based on the dominance of fine sediment along the existing winter-spring shoreline. Furthermore, the assumption that rock revetment is optimal or at least equal in suitability to gravel, cobble, or other substrate types for spawning and incubation has not been documented. Based on the general relationship between delta smelt spawning success and shallow, low-velocity habitats with dense vegetation, it is likely that the project will increase the overall suitability of these sites for delta smelt spawning and incubation.

Based on the SAM results and other design considerations not specifically addressed by the SAM, it is concluded that the compensation and habitat design objectives of the project would be met. Overall, the project would effectively compensate for short-term losses and result in significant long-term gains in nearshore and SRA cover values. Long-term benefits to listed species include substantial increases in the amount of shallow water and instream cover available to juvenile Chinook salmon and steelhead during typical winter and spring flows. Net reductions in habitat values would occur in the fall, but the effects on listed species (primarily winter-run and spring-run Chinook salmon) are expected to be minor based on the timing and abundance of juvenile salmon and the availability of key habitat features as a function of flow in the project reach. The potential effects of the project on delta smelt cannot be clearly defined because of the lack of specific information on the spawning distribution and habitat preferences of this species. Based on the general relationship between delta smelt spawning success and shallow, low-velocity habitats with dense vegetation, it is likely that the project will increase the overall suitability of these sites for delta smelt spawning and incubation.

The high SAM values associated with the Pocket bank designs, coupled with the overall habitat diversity achieved for aquatic, semi-aquatic, and terrestrial species not specifically accounted for in the SAM model variables, suggest that these integrated habitat features may represent the best possible design for meeting habitat compensation and restoration objectives under the constraints of lower river bank and levee conditions.

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Appendix A

Design Objectives for Bank Protection

SAFCA
Sacramento
Area Flood
Control
Agency

Pocket Erosion Sites and RM 56.7, Sacramento River

Design Objectives for Bank Protection

Draft July 11/05

1. Consistent with ensuring public safety; avoid or minimize loss of aquatic & riparian habitats,

2. Maximize onsite mitigation credits based on IWG's emerging SAM methodology[1], and target net gain in habitat or habitat neutral design. Accomplish optimal onsite habitat values by creating:
   - Seasonally flooded benches and placement of instream wood at varying elevations,
   - Self-sustaining, diverse riparian vegetation in planting benches and on bank slopes, including the lower 1/3 of banks to optimize shaded aquatic and shallow water habitats,
   - Minimal aquatic predator species habitat, to protect out-migrating juvenile salmonids,
   - Shoreline micro-habitats as refugia for native fish, utilizing stable but irregular bench levels and scalloped bank lines. The intent is variable, near-bank hydraulic effects and lower flow velocity;

3. Design for a high level of bank and levee stability, and persistence of bank stabilization under minimal to normal maintenance operations;

4. Limit the use of riprap above summer water surface, or conceal rock with topsoil and dense plantings;

5. Consider innovative uses of engineered materials & products (e.g., turf reinforcement mats, etc) where feasible;

6. Design to effectively attenuate boat wake energy, especially at low summer water (elevation 3'-8'), as well as spring/winter water (elevation 8'-15');

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[1] Subject to refinement. Process is underway.

7. Utilize bio-technical engineering methods, including brush boxes (i.e., temporary until vegetation is established) and reliance on vegetation to stabilize soil such as native sedge & grass cover in areas of low velocity and sheer stress;

8. Avoid over-compaction of fill material, or rock layers exceeding 1-foot thickness, so as not to hinder plant growth and root penetration;

9. Accommodate limited recreational use and improved visual conditions, without compromising other, higher priority objectives;

10. Set a design goal of less than $2000 per linear foot for construction.

Appendix B

Memorandum to NOAA Fisheries and the U.S. Fish and Wildlife Service on SAM Modifications and Refinements

Jones & Stokes

Date: October 24, 2005

To: Howard Brown, National Marine Fisheries Service
Jennifer Hobbs, U.S. Fish and Wildlife Service

cc: Steve Chainey, MIG

From: Bill Mitchell

Subject: **SAM Modifications and Refinements**

The following memorandum is a revision of the memorandum that we submitted to you on August 17, 2005. This memorandum was revised to address the comments received at the meeting on August 30, 2005 with members of the Interagency Working Group and other agencies and consultants involved in projects of the Sacramento River Bank Protection Project and River Mile 56.7 PDT.

The meeting participants expressed general support for the proposed modifications to the SAM computational and weighting procedures discussed in this memorandum. Several questions or concerns remained regarding details of the computational procedures used to quantify or weight specific SAM variables. These questions and other clarifications and refinements to the SAM model are addressed below. Meeting participants also agreed to a six-month trial period for using the SAM with the proposed modifications to determine the mitigation requirements for ongoing and proposed bank protection projects in the Sacramento Pocket Area and other Sacramento River sites. No additional modifications to the model would be considered until an interagency review occurs following the end of the six-month trial period.

Introduction

The Standard Assessment Methodology (SAM) was developed by the U.S. Army Corps of Engineers, in consultation with the Interagency Working Group, to address specific habitat assessment and regulatory needs for ongoing and future bank protection actions in the Sacramento River Bank Protection Project (SRBPP) planning area (additional background information can be found in the May 2004 SAM final review draft by Stillwater Sciences and Dean Ryan Consultants & Designers). The SAM was designed to address a number of limitations associated with previous habitat assessment approaches, and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species. A major advantage of the SAM is that it integrates species life history (life stage occurrence by reach and month) and flow-related variability in habitat quality and availability to generate species responses to project actions over time.

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Recent application of the SAM to specific projects has revealed several technical and procedural modifications that improve the accuracy of the results and the quantification of benefits associated with desired mitigation and restoration design features (e.g., graded benches, floodplain habitat). Jones & Stokes and MIG (on behalf of the Sacramento Area Flood Control Agency), NOAA Fisheries, and U.S. Fish and Wildlife Service met informally on May 17 and August 1, 2005 to discuss these modifications. The following memorandum summarizes the proposed modifications. In summary, these modifications include:

- eliminating the assumed negative response of Delta smelt juveniles and adults to nearshore cover (e.g., instream woody material [IWM] and vegetation) based on the pelagic nature of these life stages and their reduced dependence on nearshore cover,
- applying the habitat response curves for Delta smelt spawning and incubation life stages to newly-hatched larvae based on the importance of nearshore habitat to all three life stages,
- characterizing the quality of shallow water habitat based on the slope of the submerged portion of the bank rather than the slope of the bank at the water's edge,
- quantifying floodplain habitat values based on the actual area of inundated floodplain rather than the ratio of floodplain-to-channel inundation area, and
- quantifying shoreline habitat variables (IWM, aquatic vegetation, shade) based on the actual length of the existing or created shoreline (wetted shoreline contour of bank at different flows).

The primary objective of these modifications is to improve the accuracy of the SAM in quantifying differences in habitat values among project sites or alternatives, especially for projects where detailed topography, design drawings, and hydraulic data are available. It was agreed that these modifications should be limited to those that can be implemented using the original mathematical formulations and computational structure of the SAM.

Overview of SAM Computations

In general, the SAM quantifies habitat values in terms of bank line- or area-weighted species responses that are calculated by combining habitat quality (i.e., fish response index) with quantity (bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat variables and the responses of individual species and life stage (see attached figures from the SAM review draft). The response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (e.g., with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each variable for each season and target year, and multiplies these values together to generate an overall response index. This index is then multiplied by the area or linear feet of bank to which it applies to generate the weighted species response (expressed as feet or square feet). These values provide a common metric that can be used to quantify habitat values over time, compare project alternatives to baseline conditions, and evaluate the effectiveness of onsite and offsite mitigation actions.

Differences in Species Habitat Relationships (Fish Response Curves)

Problem Statement - In SAM, it is assumed that increasing amounts of nearshore cover correspond to increasing habitat values for juvenile salmonids and decreasing habitat values for Delta smelt larvae, juveniles, and adults. This conflict has raised important questions regarding the assessment of impacts and development of appropriate mitigation and restoration design objectives for bank protection projects.

In SAM, habitat values for juvenile salmon and steelhead are assumed to increase with increasing amounts of structural (e.g., instream woody material) and vegetative cover, with the highest habitat values associated with cover values between 30 and 100% (percent of total shoreline length). In contrast, habitat values for Delta smelt (larvae, juveniles, and adults) are assumed to be decrease as the amount of structural and vegetative cover increases from 50 to 100% of the shoreline length (Figures H5.3 and H6.3).

The proposed cover response of salmonids is supported by the general positive relationship between streamside cover and juvenile abundance, and is based on the hypothesis that structural and vegetative cover provides important feeding areas, shelter, and cover from predators. In contrast, the proposed negative response of Delta smelt to structural and vegetative cover assumes that these types of cover also provide habitat for larger fish that may prey on adults and juveniles. This assumption may apply to areas where structural and vegetative cover occurs in proximity to deep water or where predators have access to such cover. In this situation, however, juvenile salmonids may be equally vulnerable to predation.

The cover response for Delta smelt appears to be based on a single assumption regarding predation rather than the relative importance of specific habitats to various life stages of Delta smelt. Although Delta smelt spawning or eggs have not been documented in the field, spawning areas likely include dead-end sloughs and shallow edge waters with low water velocities and submerged woody and/or herbaceous vegetation (Moyle 2000). These habitats are thought to provide attachment sites for the adhesive eggs and protection for newly hatched larvae, which remain near the bottom until the fins and swim bladder are fully developed. At this stage (16-18 mm TL), Delta smelt become more buoyant and presumably disperse downstream to the open waters of the estuary.

Based on current knowledge of the habitat requirements of Delta smelt, it can be reasonably assumed that shallow edge waters with submerged structural and vegetative cover provide suitable conditions for Delta smelt spawning, incubation, and early larval stages. This is reflected in the SAM's bank slope, instream structure, and aquatic vegetation response curves for the spawning and incubation life stages (Figures H2.2, H5.2, and H6.2). Based on the rationale above, this relationship can also be applied to the early larval rearing period prior to swim bladder formation. Following this stage, it can be reasonably assumed that nearshore cover becomes relatively unimportant to Delta smelt once the larvae disperse into open water. In fact, the SAM assumes that habitat quality for Delta smelt juveniles and adults is unaffected by the presence of shallow water habitat because of their pelagic nature.

Proposed Modification - A simple modification to the SAM would be to use the bank slope, instream structure, and aquatic vegetation response curves for Delta smelt spawning and incubation to also characterize the response of Delta smelt larvae prior to swim bladder formation. The response curves for juvenile and adult life stages could be ignored or assumed to be neutral (i.e., no response) for these habitat variables to reflect the pelagic nature of these life stages.

Bank Slope

Problem Statement – The slope of the bank at the water's edge serves as an indirect measure of shallow water habitat that can be readily measured in the field or derived from topographic data. However, this variable may not accurately characterize the value or extent of natural or constructed features designed to create shallow water or floodplain habitat.

Bank Slope is intended to serve as an indirect measure of shallow water habitat availability, and is derived from point estimates of bank slope (horizontal change divided by vertical change) along each seasonal shoreline (i.e., the line where the water surface intersects the bank at average winter, spring, summer, and fall flows). Application of this approach to specific projects has revealed the potential for underestimating the value of natural or constructed features that provide important shallow water and floodplain habitat for listed species. Although this approach may be appropriate for large river segments where accurate delineation of such features is not feasible or practical, detailed bank protection project descriptions are often available (e.g., detailed survey data and plan drawings), allowing more accurate quantification of the habitat values associated with these features.

Figure 1 illustrates the current SAM procedure for deriving bank slopes for a generalized graded bench design (similar to that currently proposed for RM 0.5 on the Lower American River) (Figure 1). A major objective of this design is to create shallow water habitat by lowering the bank and creating a gently sloped bench (≥10:1) that is frequently inundated and available to juvenile fish during typical winter and spring flows. It is hypothesized that slopes of 10:1 or greater correspond to optimum shallow water habitat for young salmon (Figure H2.3), which reach peak abundance in the lower Sacramento and American Rivers during the winter and spring.

In SAM, changes in the quality of shallow water habitat resulting from a proposed action are based on projected changes in bank slope along the average seasonal shorelines. As shown in Figure 1, the graded bench design would result in the creation of a 100-foot wide band of high-quality (>10:1 slope) shallow water habitat during average winter and spring flows. However, point estimates of bank slope at the intersection of the bank with the average winter and spring water surface would be 2:1, resulting in no detected change in habitat quality relative to existing conditions.

Proposed Modification - This problem can be partially remedied by using an average bank slope that includes point estimates from the submerged portion of the bank. However, in cases where detailed topography, plan drawings, and/or cross-sections are available, the most accurate and direct method for characterizing the quality of shallow water habitat would be to assign a bank slope equal to the dominant slope of the submerged portion of the bank for each flow (in the case of Figure 1, >10:1 for winter and spring flows). Accordingly, SAM would compute the incremental effect of this variable on overall habitat values by combining the corresponding fish response index (1.0) with the associated increase in wetted area resulting from the graded bench (100 feet multiplied by the length of the site).

Floodplain Habitat

Problem Statement – In SAM, floodplain habitat values are based on the ratio of inundated floodplain width (based on the flood stage that occurs every two years on average) to the inundated channel width (based on the average winter-spring river stage). This ratio provides an indicator of floodplain habitat availability but may not accurately reflect the biological benefits associated with actual floodplain area.

The SAM quantifies the availability of floodplain habitat to listed species based on the ratio of the wetted floodplain width or area at the two-year flood-return flow to the wetted width or area of the river at the average winter-spring flow. For example, according to the response curve for juvenile salmon, the response index ranges from 0.3 for a floodplain inundation ratio of 2:1 to 1.0 for a ratio of 12:1 (Figure H3.3).

Figure 2 illustrates the current SAM procedure for computing floodplain inundation ratios. In this example, the floodplain inundation ratio is 2:1, corresponding to a wetted width of 1,000 feet for the two-year flood-return flow and a wetted width of 500 feet for the average winter-spring flow (measured from the midline of the river channel). If this represents newly created floodplain, approximately 11.5 acres of new floodplain habitat would be created for every 1,000 linear feet of river. However, for juvenile salmon, the only change in habitat values recognized by the SAM would be an increase in the floodplain response index from 0.2 to 0.3, corresponding to an increase in floodplain inundation from 1:1 to 2:1 (Figure H3.3). Currently, there is no means of weighting the fish response indices by floodplain inundation area or adding the contribution of other variables (e.g., vegetation) to floodplain habitat values.

The use of floodplain to channel ratios to characterize floodplain habitat availability appears to be based on general geomorphic principles that apply to unconfined alluvial streams, and on the assumption that floodplain morphology of the Sacramento River is similar across the region. However, there seems to be no biological rationale for quantifying floodplain values in this manner. A more accurate and direct measure of the habitat values associated with floodplains is the actual area of inundated floodplain surface, which relates directly to the amount of potential living space for fish, site suitability for floodplain vegetation, and overall productive capacity of floodplains.

Proposed Modification - An alternative approach to evaluating floodplain habitat with the current version of the SAM is to use the bank slope variable to quantify floodplain values and run the SAM computational procedure separately for floodplain and in-channel habitat (defined by shallow water, cover, substrate, and shade along each seasonal shoreline). The bank slope variable offers a means of weighting the fish response index by floodplain inundation area and the flexibility to include other habitat variables (e.g., vegetation) in the overall computation of floodplain habitat values. This approach would entail setting the bank slope variable to 10:1 (corresponding to a fish response index of 1.0) and weighting the index by the area of floodplain inundation for the two-year flood-return flow (excluding the wetted area of the river channel).

At the August 30 meeting, a concern was raised about the proposal to generate separate results for floodplain and in-channel habitat. A suggested alternative was to generate one value representing both in-channel and floodplain habitat by weighting bank slope values for each habitat by the area and amount of time that these habitats are available to fish. For example, bank slope values associated with shoreline habitat that is available every year could be multiplied by 1 while bank slope values associated with floodplain habitat that is available every 2 years could be multiplied by 0.5. While this is a logical alternative, the computational structure of the SAM does not allow the bank slope variable to be weighted differently from other variables (i.e., all variables receive the same weighting factor).

Shoreline Length

Problem Statement – In SAM, the extent of IWM, aquatic vegetation, and shade are measured in terms of bank line coverage (percent of total bank length). A simple straight-line measurement of a site's length and the amount of cover or shade intersecting this line may not accurately reflect the increased habitat values associated with variable shoreline lengths at different flows.

As described above, the SAM quantifies habitat values in terms of bank line- or area-weighted species responses that are calculated by combining habitat quality (i.e., fish response index) with quantity (bank length or wetted area). Because instream structure, aquatic vegetation, and shade are measured in terms of bank line coverage (percent of total bank length), weighting by bank length is most appropriate for these variables. A common objective of onsite and offsite mitigation for bank protection projects on the Sacramento and Lower American Rivers is to enhance habitat diversity and complexity of nearshore areas by incorporating variable bank elevations and slopes in the design (e.g., planting berms, embayments). These features also increase the quantity of available habitat by increasing the length of the shoreline and the extent of cover and shade along the water's edge.

Proposed Modification - For projects where detailed survey data and design drawings are available, weighting the fish response indices by the effective shoreline length corresponding to each seasonal water surface elevation provides a means of accurately quantifying the habitat values associated with variable shoreline features. Figure 3 illustrates the measurement of seasonal shoreline lengths for a generalized version of the graded bench design proposed for RM 0.5 on the lower American River. In this example, shoreline lengths for the highlighted segment vary from approximately 400 feet at elevations of 0-2 feet (corresponding roughly to the shoreline length under existing conditions) to approximately 860 feet at average summer flows.

One of the questions raised at the August 30 meeting was whether bank line weighting of shoreline habitat variables could be used in combination with area weighting of shallow-water and floodplain habitat variables to compute overall habitat values at a given site. Unfortunately, as stated above under "Floodplain Habitat", the computational structure of the SAM does not allow different weighting factors to be applied to different variables. Consequently, the only way to apply different weighting factors to different variables is to conduct separate runs of the SAM as proposed above for floodplain and in-channel habitat. Otherwise, it will be necessary to decide which type of weighting (area or bankline) provides the most accurate or meaningful measure of existing or desired habitat values at a given site.

Advantages of SAM Modifications

The modifications and refinements to the SAM recommended above offer three important advantages to successful implementation of the SAM for future SRBPP projects and associated mitigation actions:

- For each successive bank protection project, optimizing the project's SAM mitigation values creates an incentive to incorporate design features (both onsite and offsite) that result in high-value habitats for a range of species throughout the hydrologic year.

- Modifications improve the scientific accuracy and precision of particular response variables, adding to greater credibility and technical defensibility of SAM model assumptions, results, and applications.

- Improving scientific precision and defensibility of the SAM will help promote wider acceptability by local, state, and federal flood management agencies of the habitat mitigation requirements quantified by SAM for bank protection projects.

Appendix C
SAM Input Data

Table C-1. RM 49.6L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	96,850	96,850	96,850	96,850
Shoreline Length (feet)	298	298	298	298
Bank Slope (dW:dH)	7:1	2:1	2:1	7:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	42	53	53	42
Vegetation (% shoreline)	1	27	27	1
Shade (% shoreline)	13	45	45	13

Table C-2. RM 49.6L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	96,850	96,850	96,850	96,850
Shoreline Length (feet)	298	298	298	298
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	45	45	40
Vegetation (% shoreline)				
Year 0	1	27	27	1
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	13	45	45	13
Year 1	0	10	10	0
Year 5	0	10	10	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-3. RM 49.9L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	96,800	96,800	96,800	96,800
Shoreline Length (feet)	268	268	268	268
Bank Slope (dW:dH)	6:1	2:1	2:1	6:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	29	67	67	29
Vegetation (% shoreline)	0	60	60	0
Shade (% shoreline)	18	56	56	18

Table C-4. RM 49.9L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	96,800	96,800	96,800	96,800
Shoreline Length (feet)	268	268	268	268
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	60	60	40
Vegetation (% shoreline)				
Year 0	0	60	60	0
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	18	56	56	18
Year 1	0	23	23	0
Year 5	0	23	23	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-5. RM 50.2L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	515,550	515,550	515,550	515,550
Shoreline Length (feet)	1,473	1,473	1,473	1,473
Bank Slope (dW:dH)	7:1	2:1	2:1	7:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	38	64	64	38
Vegetation (% shoreline)	2	30	30	2
Shade (% shoreline)	10	26	26	10

Table C-6. RM 50.2L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	515,550	515,550	515,550	515,550
Shoreline Length (feet)	1,473	1,473	1,473	1,473
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	53	53	40
Vegetation (% shoreline)				
Year 0	2	30	30	2
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	10	26	26	10
Year 1	0	17	17	0
Year 5	0	17	17	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-7. RM 50.4L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	98,700	98,700	98,700	98,700
Shoreline Length (feet)	329	329	329	329
Bank Slope (dW:dH)	3:1	2:1	2:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	10	10	10
Instream Structure (% shoreline)	22	33	33	22
Vegetation (% shoreline)	0	4	4	0
Shade (% shoreline)	17	21	21	17

Table C-8. RM 50.4L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	98,700	98,700	98,700	98,700
Shoreline Length (feet)	329	329	329	329
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	45	45	40
Vegetation (% shoreline)				
Year 0	0	4	4	0
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	17	21	21	17
Year 1	0	17	17	0
Year 5	0	17	17	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-9. RM 50.8L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	268,200	268,200	268,200	268,200
Shoreline Length (feet)	894	894	894	894
Bank Slope (dW:dH)	10:1	2:1	2:1	10:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	13	33	33	13
Vegetation (% shoreline)	7	57	57	7
Shade (% shoreline)	3	9	9	3

Table C-10. RM 50.8L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	268,200	268,200	268,200	268,200
Shoreline Length (feet)	894	894	894	894
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	50	50	40
Vegetation (% shoreline)				
Year 0	7	57	57	7
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	3	9	9	3
Year 1	0	5	5	0
Year 5	0	5	5	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-11. RM 51.5L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	266,400	266,400	266,400	266,400
Shoreline Length (feet)	888	888	888	888
Bank Slope (dW:dH)	9:1	2:1	2:1	9:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	27	46	46	27
Vegetation (% shoreline)	1	55	55	1
Shade (% shoreline)	11	23	23	11

Table C-12. RM 51.5L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	266,400	266,400	266,400	266,400
Shoreline Length (feet)	888	888	888	888
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	49	49	40
Vegetation (% shoreline)				
Year 0	1	55	55	1
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	11	23	23	11
Year 1	0	4	4	0
Year 5	0	4	4	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-13. RM 52.4L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	58,100	58,100	58,100	58,100
Shoreline Length (feet)	166	166	166	166
Bank Slope (dW:dH)	4:1	2:1	2:1	4:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	3	3	3	3
Vegetation (% shoreline)	0	77	77	0
Shade (% shoreline)	14	16	16	14

Table C-14. RM 52.4L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	58,100	58,100	58,100	58,100
Shoreline Length (feet)	166	166	166	166
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	0	77	77	0
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	14	16	16	14
Year 1	0	10	10	0
Year 5	0	10	10	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Table C-15. RM 53.1L – SAM Input Values (Existing Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	27,000	27,000	27,000	27,000
Shoreline Length (feet)	120	120	120	120
Bank Slope (dW:dH)	3:1	2:1	2:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	0.01	0.01	0.01	0.01
Instream Structure (% shoreline)	0	0	0	0
Vegetation (% shoreline)	0	37	37	0
Shade (% shoreline)	13	13	13	13

Table C-16. RM 53.1L – SAM Input Values (With-Project Conditions)

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.8	9.8	8.5	5.3
Wetted Area (square feet)	27,000	27,000	27,000	27,000
Shoreline Length (feet)	120	120	120	120
Bank Slope (dW:dH)	3:1	10:1	10:1	3:1
Floodplain Inundation Ratio (AQ2:AQavg)	1:1	1:1	1:1	1:1
Bank Substrate Size (D50 in inches)	10	0.01	0.01	10
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	0	37	37	0
Year 1	0	20	20	0
Year 5	0	50	50	0
Year 15	0	75	75	0
Year 25	0	75	75	0
Year 50	0	75	75	0
Shade (% shoreline)				
Year 0	13	13	13	13
Year 1	0	0	0	0
Year 5	0	0	0	0
Year 15	10	50	50	10
Year 25	10	50	50	10
Year 50	10	50	50	10

Attachment C
Corps Additional 5 Sites SAM Report

Standard Assessment Methodology (SAM) Data and Results

Table B-1
SAM Data Summary for Existing Conditions at Site RM 26.9

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	1.9	2.9	2.6	2.1
Wetted Area (square feet)	170,436	174,613	173,388	171,261
Shoreline Length (feet)	575	575	575	575
Bank Slope (dW:dH)	2.2	2.0	2.1	2.2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.10	1.10	1
Bank Substrate Size (D50 in inches)	11	11	11	11
Instream Structure (% shoreline)	4	4	4	4
Vegetation (% shoreline)	0	88	88	0
Shade (% shoreline)	8	2	6	8

Table B-2
SAM Data Summary of Project Conditions for Site RM 26.9

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	1.9	2.9	2.6	2.1
Wetted Area (square feet)	170,436	174,613	173,388	171,261
Shoreline Length (feet)	575	575	575	575
Bank Slope (dW:dH)	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.17	1.18	1
Bank Substrate Size (D50 in inches)	12	0.06	0.06	12
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	78	78	78	78
Year 1	78	83	83	78
Year 5	78	88	88	78
Year 15	78	88	88	78
Year 25	78	88	88	78
Year 50	78	88	88	78
Shade (% shoreline)				
Year 0	10	2	7	10
Year 1	10	2	7	10
Year 5	10	4	7	10
Year 15	22	8	15	22
Year 25	52	20	45	52
Year 50	80	20	60	80

Table B-3
SAM Data Summary for Existing Conditions at Site RM 34.5

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2.4	3.9	3.4	2.7
Wetted Area (square feet)	192,873	194,715	194,115	193,373
Shoreline Length (feet)	635	635	635	635
Bank Slope (dW:dH)	1.9	1.9	1.9	1.9
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.04	1.05	1
Bank Substrate Size (D50 in inches)	20	20	20	20
Instream Structure (% shoreline)	6	6	6	6
Vegetation (% shoreline)	0	88	88	0
Shade (% shoreline)	16	4	12	16

Table B-4
SAM Data Summary of Project Conditions for Site RM 34.5

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2.4	3.9	3.4	2.7
Wetted Area (square feet)	192,873	194,715	194,115	193,373
Shoreline Length (feet)	635	635	635	635
Bank Slope (dW:dH)	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.11	1.12	1
Bank Substrate Size (D50 in inches)	12	0.06	0.06	12
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	71	71	71	71
Year 1	71	78	78	71
Year 5	71	88	88	71
Year 15	71	88	88	71
Year 25	71	88	88	71
Year 50	71	88	88	71
Shade (% shoreline)				
Year 0	4	1	3	4
Year 1	4	1	3	4
Year 5	4	3	3	4
Year 15	16	7	11	16
Year 25	46	20	41	46
Year 50	80	20	60	80

Table B-5
SAM Data Summary for Existing Conditions at Site RM 72.2

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	7.3	12.4	10.5	8.5
Wetted Area (square feet)	429,067	450,024	441,922	433,842
Shoreline Length (feet)	1,666	1,666	1,666	1,666
Bank Slope (dW:dH)	2.2	2.2	2.2	2.2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.10	1.12	1
Bank Substrate Size (D50 in inches)	4	4	4	4
Instream Structure (% shoreline)	24	24	24	24
Vegetation (% shoreline)	0	88	88	0
Shade (% shoreline)	40	10	30	40

Table B-6
SAM Data Summary of Project Conditions for Site RM 72.2

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	7.3	12.4	10.5	8.5
Wetted Area (square feet)	429,067	450,024	441,922	433,842
Shoreline Length (feet)	1,666	1,666	1,666	1,666
Bank Slope (dW:dH)	2.5	10	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.19	1.21	1
Bank Substrate Size (D50 in inches)	12	0.06	12	12
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	0	50	50	0
Year 1	0	75	75	0
Year 5	0	88	88	0
Year 15	0	88	88	0
Year 25	0	88	88	0
Year 50	0	88	88	0
Shade (% shoreline)				
Year 0	10	2	7	10
Year 1	10	2	7	10
Year 5	10	4	7	10
Year 15	22	8	15	22
Year 25	52	20	45	52
Year 50	80	20	60	80

Table B-7
SAM Data Summary for Existing Conditions at Site RM 99.3

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	20.4	26.3	24.4	21.7
Wetted Area (square feet)	56,460	68,606	65,291	58,413
Shoreline Length (feet)	416	416	416	416
Bank Slope (dW:dH)	2.4	2.5	3.5	2.7
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.17	1.23	1
Bank Substrate Size (D50 in inches)	12	12	12	12
Instream Structure (% shoreline)	0	0	0	0
Vegetation (% shoreline)	0	75	76	0
Shade (% shoreline)	0	0	0	0

Table B-8
SAM Data Summary of Project Conditions for Site RM 99.3

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	20.4	26.3	24.4	21.7
Wetted Area (square feet)	56,460	68,606	65,291	58,413
Shoreline Length (feet)	416	416	416	416
Bank Slope (dW:dH)	2.5	10	10	2.5
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.33	1.41	1
Bank Substrate Size (D50 in inches)	12	0.06	0.06	12
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	0	50	50	0
Year 1	0	75	75	0
Year 5	0	75	76	0
Year 15	0	75	76	0
Year 25	0	75	76	0
Year 50	0	75	76	0
Shade (% shoreline)				
Year 0	0	0	0	0
Year 1	0	0	0	0
Year 5	0	2	0	0
Year 15	12	6	8	12
Year 25	42	20	38	42
Year 50	80	20	60	80

Table B-9
SAM Data Summary for Existing Conditions at Site RM 123.5

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	26.2	31.6	30.1	28.8
Wetted Area (square feet)	49,639	53,759	52,539	51,544
Shoreline Length (feet)	540	540	540	540
Bank Slope (dW:dH)	1.5	1.6	1.5	1.5
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.29	1.32	1
Bank Substrate Size (D50 in inches)	18	18	18	18
Instream Structure (% shoreline)	0	0	0	0
Vegetation (% shoreline)	0	88	88	0
Shade (% shoreline)	1	0	1	1

Table B-10
SAM Data Summary of Project Conditions for Site RM 123.5

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	26.2	31.6	30.1	28.8
Wetted Area (square feet)	49,639	53,759	52,539	51,544
Shoreline Length (feet)	540	540	540	540
Bank Slope (dW:dH)	2	10	2	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.46	1.50	1
Bank Substrate Size (D50 in inches)	12	0.06	12	12
Instream Structure (% shoreline)	40	40	40	40
Vegetation (% shoreline)				
Year 0	0	50	50	0
Year 1	0	75	75	0
Year 5	0	88	88	0
Year 15	0	88	88	0
Year 25	0	88	88	0
Year 50	0	88	88	0
Shade (% shoreline)				
Year 0	0	0.0927	0	0
Year 1	0	0	0	0
Year 5	0	2	0	0
Year 15	12	6	8	12
Year 25	42	20	38	42
Year 50	80	20	60	80

Table B-11
SAM results showing bank-line weighted relative response (feet) at RM 26.9.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	27		11	90		35		16	76		29		14	74		27		11		
Year 5	27		11	90		36		17	78		29		14	74		27		11		
Year 15	30		14	96		38		20	87		31		17	81		30		14		
Year 25	35		18	104		40		24	96		35		24	92		35		18		
Year 50	43		25	113		44		30	110		44		36	107		43		25		
Central Valley fall-run chinook salmon																				
Year 0	0		0					0	0		0			0		0				
Year 1	27		11					16	76		29			74		27				
Year 5	27		11					17	78		29			74		27				
Year 15	30		14					20	87		31			81		30				
Year 25	35		18					24	96		35			92		35				
Year 50	43		25					30	110		44			107		43				
Central Valley late fall-run chinook salmon																				
Year 0	0			0		0			0		0		0							
Year 1	27			90		35			76		29		14							
Year 5	27			90		36			78		29		14							
Year 15	30			96		38			87		31		17							
Year 25	35			104		40			96		35		24							
Year 50	43			113		44			110		44		36							
Sacramento River winter-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	27		11	90		35		16	76		29		14	74		27		11		
Year 5	27		11	90		36		17	78		29		14	74		27		11		
Year 15	30		14	96		38		20	87		31		17	81		30		14		
Year 25	35		18	104		40		24	96		35		24	92		35		18		
Year 50	43		25	113		44		30	110		44		36	107		43		25		
Central Valley steelhead																				
Year 0	0		0		0	0		0	0	0	0		0	0	0	0		0		0
Year 1	65		20		65	75		26	58	66	66		21	51	66	65		20		65
Year 5	65		20		65	75		27	59	66	66		21	51	66	65		20		65
Year 15	70		24		70	80		32	65	70	70		26	56	70	70		24		70
Year 25	79		31		79	85		37	72	78	78		35	65	78	79		31		79
Year 50	92		41		92	93		46	83	92	92		51	79	92	92		41		92
Delta Smelt																				
Year 0	0				0	0	0	0		0	0	0	0		0	0	0	0		0
Year 1	0				0	0	-246	-246		0	0	-246	-246		0	0	-246	-246		0
Year 5	0				0	0	-246	-246		0	0	-246	-246		0	0	-246	-246		0
Year 15	0				0	0	-246	-246		0	0	-246	-246		0	0	-246	-246		0
Year 25	0				0	0	-246	-246		0	0	-246	-246		0	0	-246	-246		0
Year 50	0				0	0	-246	-246		0	0	-246	-246		0	0	-246	-246		0

Notes: 1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River.
2 Results calculated from time-averaged relative respnses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2004).

Table B-12
SAM results showing bank-line weighted relative response (feet) at RM 34.5.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	29		15	105		35		22	111		31		22	103		29		15		
Year 5	29		15	105		35		22	111		31		22	103		29		15		
Year 15	32		17	114		37		25	119		33		25	113		32		17		
Year 25	38		22	125		40		30	131		38		33	127		38		22		
Year 50	48		31	138		45		37	148		48		47	147		48		31		
Central Valley fall-run chinook salmon																				
Year 0	0		0					0	0		0			0		0				
Year 1	29		15					22	111		31			103		29				
Year 5	29		15					22	111		31			103		29				
Year 15	32		17					25	119		33			113		32				
Year 25	38		22					30	131		38			127		38				
Year 50	48		31					37	148		48			147		48				
Central Valley late fall-run chinook salmon																				
Year 0	0			0		0			0		0		0							
Year 1	29			105		35			111		31		22							
Year 5	29			105		35			111		31		22							
Year 15	32			114		37			119		33		25							
Year 25	38			125		40			131		38		33							
Year 50	48			138		45			148		48		47							
Sacramento River winter-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	29		15	105		35		22	111		31		22	103		29		15		
Year 5	29		15	105		35		22	111		31		22	103		29		15		
Year 15	32		17	114		37		25	119		33		25	113		32		17		
Year 25	38		22	125		40		30	131		38		33	127		38		22		
Year 50	48		31	138		45		37	148		48		47	147		48		31		
Central Valley steelhead																				
Year 0	0		0		0	0		0	0	0	0		0	0	0	0		0		0
Year 1	64		29		64	74		40	86	67	67		38	78	67	64		29		64
Year 5	64		29		64	74		40	86	67	67		38	78	67	64		29		64
Year 15	71		34		71	78		43	92	72	72		43	85	72	71		34		71
Year 25	81		42		81	85		50	101	81	81		53	96	81	81		42		81
Year 50	97		54		97	95		61	114	98	98		72	114	98	97		54		97
Delta Smelt																				
Year 0	0				0	0	0	0		0	0	0	0		0	0	0	0		0
Year 1	0				0	0	-263	-263		0	0	-263	-263		0	0	187	187		0
Year 5	0				0	0	-263	-263		0	0	-263	-263		0	0	187	187		0
Year 15	0				0	0	-263	-263		0	0	-263	-263		0	0	187	187		0
Year 25	0				0	0	-263	-263		0	0	-263	-263		0	0	187	187		0
Year 50	0				0	0	-263	-263		0	0	-263	-263		0	0	187	187		0

Notes: 1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River.
2 Results calculated from time-averaged relative respnses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2004).

Table B-13
SAM results showing bank-line weighted relative response (feet) at RM 72.2.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	1		-38	-89		23		49	148		5		-71	-146		1		-38		
Year 5	1		-38	-89		23		49	155		5		-71	-140		1		-38		
Year 15	8		-34	-77		28		59	181		10		-65	-121		8		-34		
Year 25	21		-28	-63		36		79	215		22		-52	-98		21		-27		
Year 50	44		-18	-46		47		108	261		44		-29	-65		44		-18		
Central Valley fall-run chinook salmon																				
Year 0	0		0					0	0		0			0		0				
Year 1	1		-38					49	148		5			-146		1				
Year 5	1		-38					49	155		5			-140		1				
Year 15	8		-34					59	181		10			-121		8				
Year 25	21		-28					79	215		22			-98		21				
Year 50	44		-18					108	261		44			-65		44				
Central Valley late fall-run chinook salmon																				
Year 0	0			0		0			0		0		0							
Year 1	1			-89		23			148		5		-71							
Year 5	1			-89		23			155		5		-71							
Year 15	8			-77		28			181		10		-65							
Year 25	21			-63		36			215		22		-52							
Year 50	44			-46		47			261		44		-29							
Sacramento River winter-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	1		-38	-89		23		49	148		5		-71	-146		1		-38		
Year 5	1		-38	-89		23		49	155		5		-71	-140		1		-38		
Year 15	8		-34	-77		28		59	181		10		-65	-121		8		-34		
Year 25	21		-28	-63		36		79	215		22		-52	-98		21		-27		
Year 50	44		-18	-46		47		108	261		44		-29	-65		44		-18		
Central Valley steelhead																				
Year 0	0		0		0	0		0	0	0	0		0	0	0	0		0		0
Year 1	15		-57		15	45		74	135	17	17		-88	-103	17	15		-57		15
Year 5	15		-57		15	45		74	136	17	17		-88	-102	17	15		-57		15
Year 15	29		-50		29	55		87	152	28	28		-78	-88	28	29		-50		29
Year 25	51		-39		51	71		112	176	49	49		-60	-67	49	51		-38		51
Year 50	86		-22		86	94		147	210	85	85		-27	-35	85	86		-21		86
Delta Smelt																				
Year 0	0				0	0	0	0		0	0	0	0		0	0	0	0		0
Year 1	0				0	0	992	992		0	0	845	845		0	0	570	570		0
Year 5	0				0	0	992	992		0	0	845	845		0	0	570	570		0
Year 15	0				0	0	992	992		0	0	845	845		0	0	570	570		0
Year 25	0				0	0	992	992		0	0	845	845		0	0	570	570		0
Year 50	0				0	0	992	992		0	0	845	845		0	0	570	570		0

Notes: 1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River.
2 Results calculated from time-averaged relative respnses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2004).

Table B-14
SAM results showing bank-line weighted relative response (feet) at RM 99.3.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
Year 0	0		0			0		0	0		0		0	0		0		0		
Year 1	34		3			34		27	103		34		28	99		34		3		
Year 5	34		3			35		28	105		34		28	101		34		3		
Year 15	37		4			36		31	113		36		31	108		37		4		
Year 25	40		6			38		36	121		39		40	120		40		6		
Year 50	47		9			41		44	134		46		57	138		47		9		
Central Valley fall-run chinook salmon																				
Year 0	0		0					0	0		0			0		0				
Year 1	34		3					27	103		34			99		34				
Year 5	34		3					28	105		34			101		34				
Year 15	37		4					31	113		36			108		37				
Year 25	40		6					36	121		39			120		40				
Year 50	47		9					44	134		46			138		47				
Central Valley late fall-run chinook salmon																				
Year 0	0			0		0			0		0		0							
Year 1	34			26		34			103		34		28							
Year 5	34			26		35			105		34		28							
Year 15	37			31		36			113		36		31							
Year 25	40			37		38			121		39		40							
Year 50	47			44		41			134		46		57							
Sacramento River winter-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0	0	
Year 1	34		3	26		34		27	103		34		28	99		34		3	25	
Year 5	34		3	26		35		28	105		34		28	101		34		3	25	
Year 15	37		4	31		36		31	113		36		31	108		37		4	30	
Year 25	40		6	37		38		36	121		39		40	120		40		6	36	
Year 50	47		9	44		41		44	134		46		57	138		47		9	43	
Central Valley steelhead																				
Year 0	0		0	0	0	0		0	0	0	0		0	0	0	0		0	0	0
Year 1	69		8	28	69	69		44	86	69	69		44	82	69	69		8	26	69
Year 5	69		8	28	69	69		44	87	69	69		44	83	69	69		8	26	69
Year 15	73		10	32	73	73		49	93	72	72		48	88	72	73		10	31	73
Year 25	81		14	38	81	77		55	99	79	79		59	97	79	81		14	37	81
Year 50	92		19	47	92	83		65	108	90	90		78	112	90	92		19	46	92
Delta Smelt																				
Year 0	*Delta smelt not modeled upstream of Reach 1 (RM 0-80)*																			
Year 1																				
Year 5																				
Year 15																				
Year 25																				
Year 50																				

Notes: 1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River.
2 Results calculated from time-averaged relative respsnses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2004).

Table B-15
SAM results showing bank-line weighted relative response (feet) at RM 123.5.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
Year 0	0		0			0		0	0		0		0	0		0		0		
Year 1	46		5			46		42	156		46		13	65		45		5		
Year 5	46		5			46		43	160		46		13	67		45		5		
Year 15	48		6			48		48	171		48		15	75		48		6		
Year 25	53		9			51		55	183		52		20	86		53		9		
Year 50	62		12			55		59	182		61		30	102		62		12		
Central Valley fall-run chinook salmon																				
Year 0	0		0					0	0		0			0		0				
Year 1	46		5					42	156		46			65		45				
Year 5	46		5					43	160		46			67		45				
Year 15	48		6					48	171		48			75		48				
Year 25	53		9					55	183		52			86		53				
Year 50	62		12					59	182		61			102		62				
Central Valley late fall-run chinook salmon																				
Year 0	0			0		0			0		0		0							
Year 1	46			42		46			156		46		13							
Year 5	46			42		46			160		46		13							
Year 15	48			48		48			171		48		15							
Year 25	53			56		51			183		52		20							
Year 50	62			66		55			182		61		30							
Sacramento River winter-run chinook salmon																				
Year 0	0		0	0		0		0	0		0		0	0		0		0	0	
Year 1	46		5	42		46		42	156		46		13	65		45		5	42	
Year 5	46		5	42		46		43	160		46		13	67		45		5	42	
Year 15	48		6	48		48		48	171		48		15	75		48		6	48	
Year 25	53		9	56		51		55	183		52		20	86		53		9	56	
Year 50	62		12	66		55		59	182		61		30	102		62		12	66	
Central Valley steelhead																				
Year 0	0		0	0	0	0		0	0	0	0		0	0	0	0		0	0	0
Year 1	91		13	45	91	92		68	135	92	92		26	61	92	91		12	44	91
Year 5	91		13	45	91	93		69	136	92	92		27	62	92	91		12	44	91
Year 15	97		15	51	97	97		75	143	96	96		30	67	96	97		15	50	97
Year 25	107		19	59	107	102		84	151	104	104		38	77	104	106		19	59	106
Year 50	122		26	70	122	111		88	152	120	120		52	93	120	122		26	70	122
Delta Smelt																				
Year 0	*Delta smelt not modeled upstream of Reach 1 (RM 0-80)*																			
Year 1																				
Year 5																				
Year 15																				
Year 25																				
Year 50																				

Notes: 1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River.
2 Results calculated from time-averaged relative respnses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2004).

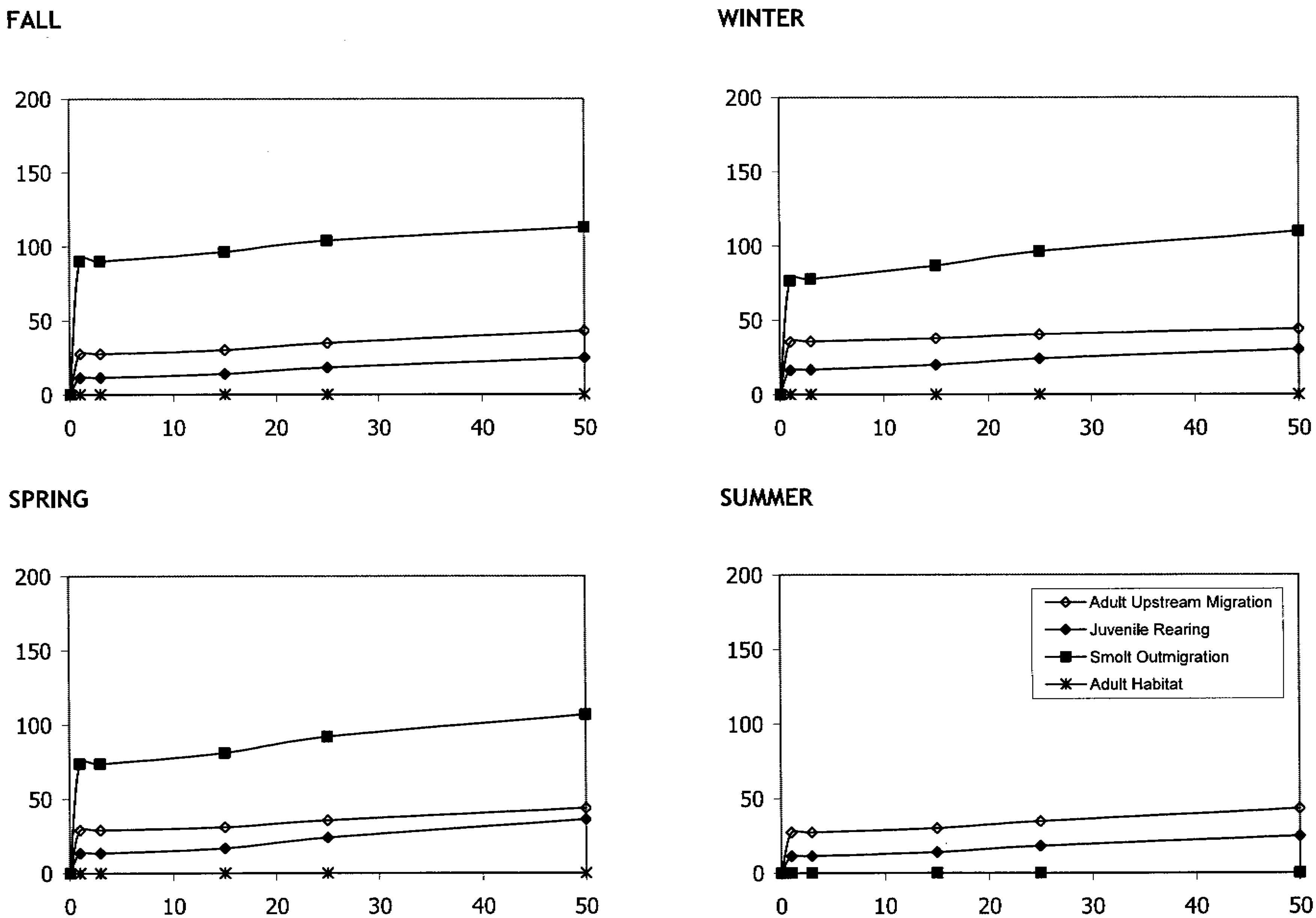


Figure B-1. SAM results showing bank-line weighted relative response (feet) for Chinook salmon (Winter-run shown) at RM 26.9.

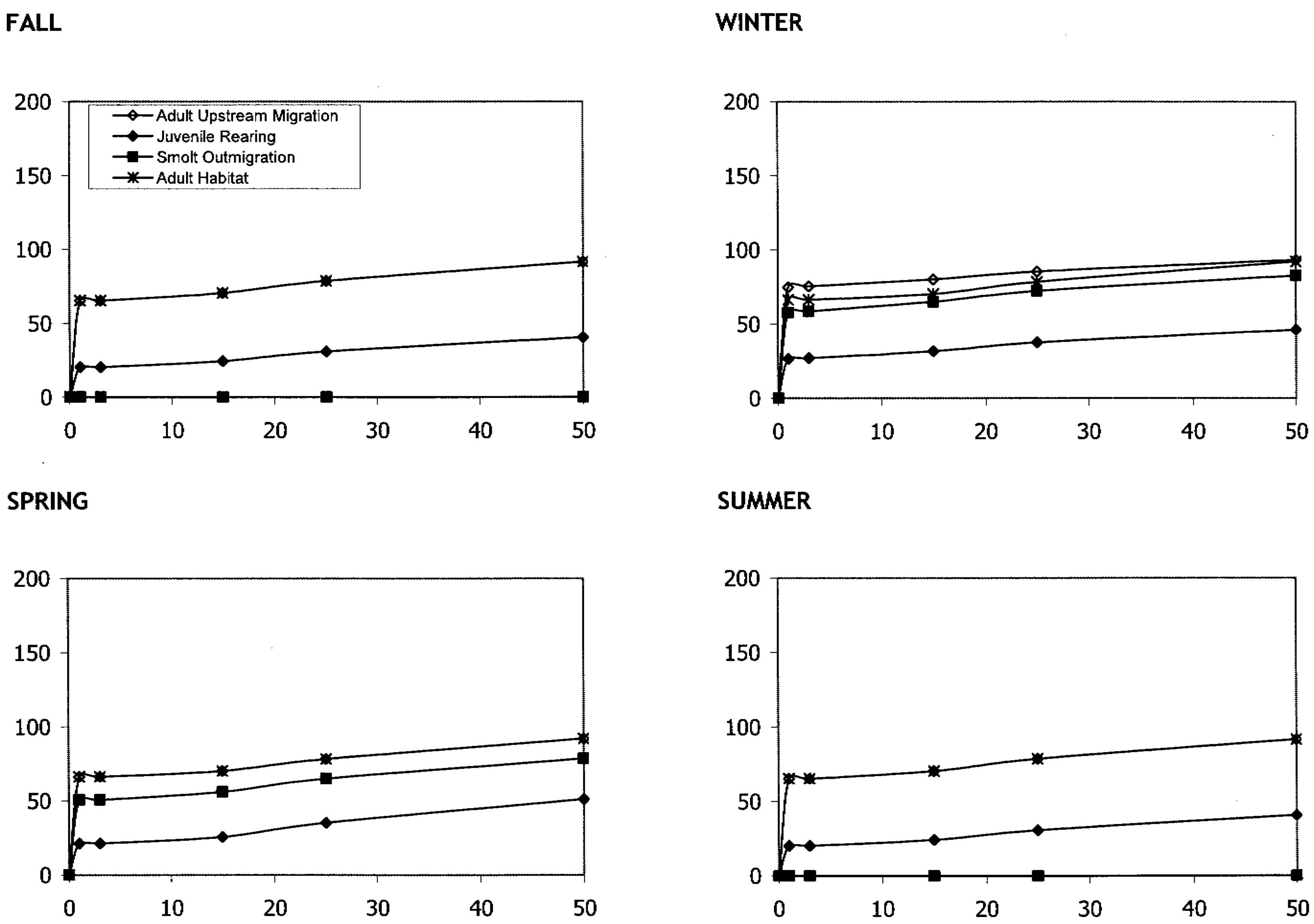


Figure B-2. SAM results showing bank-line weighted relative response (feet) for Central Valley steelhead at RM 26.9.

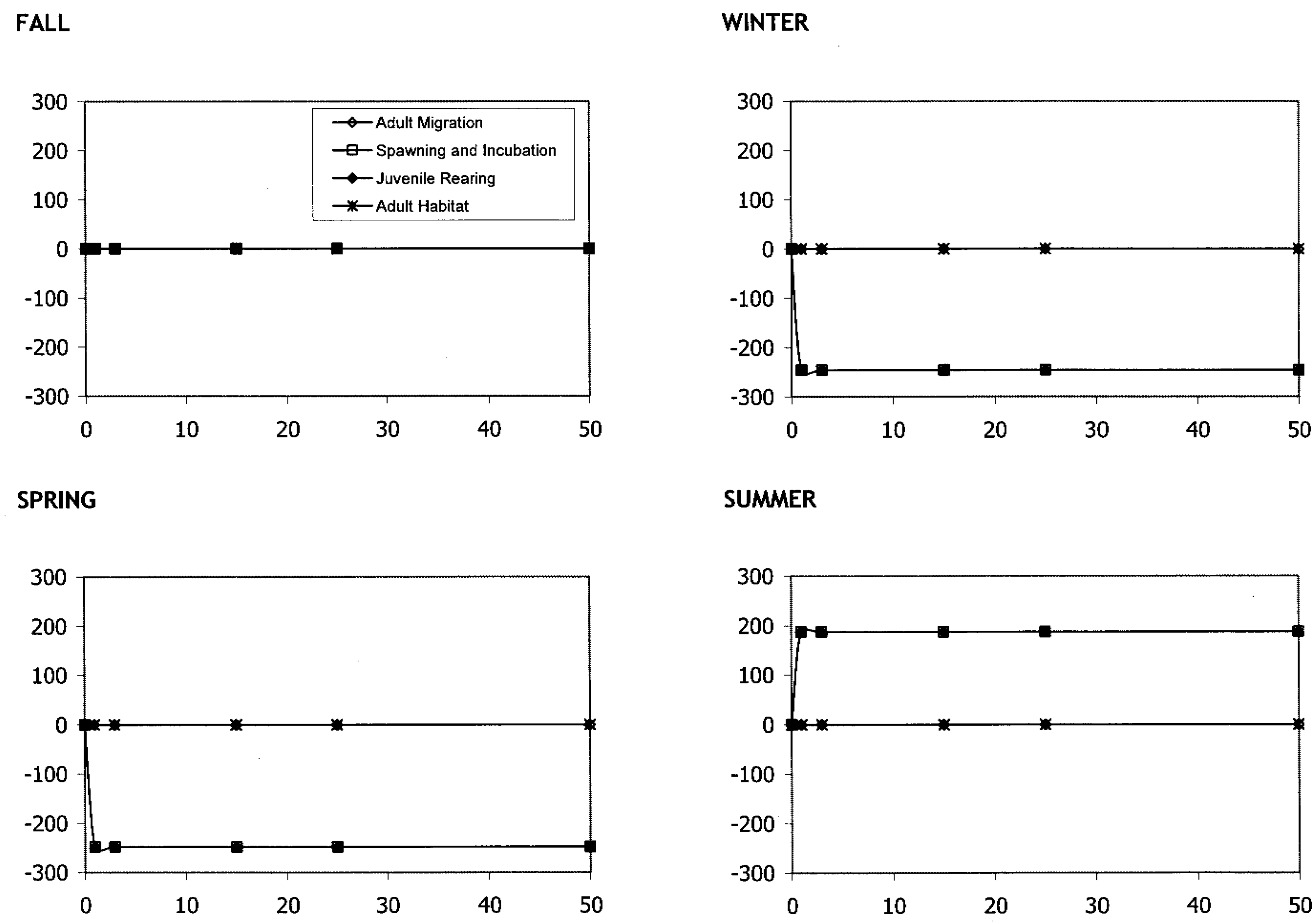


Figure B-3. SAM results showing bank-line weighted relative response (feet) for Delta smelt at RM 26.9.

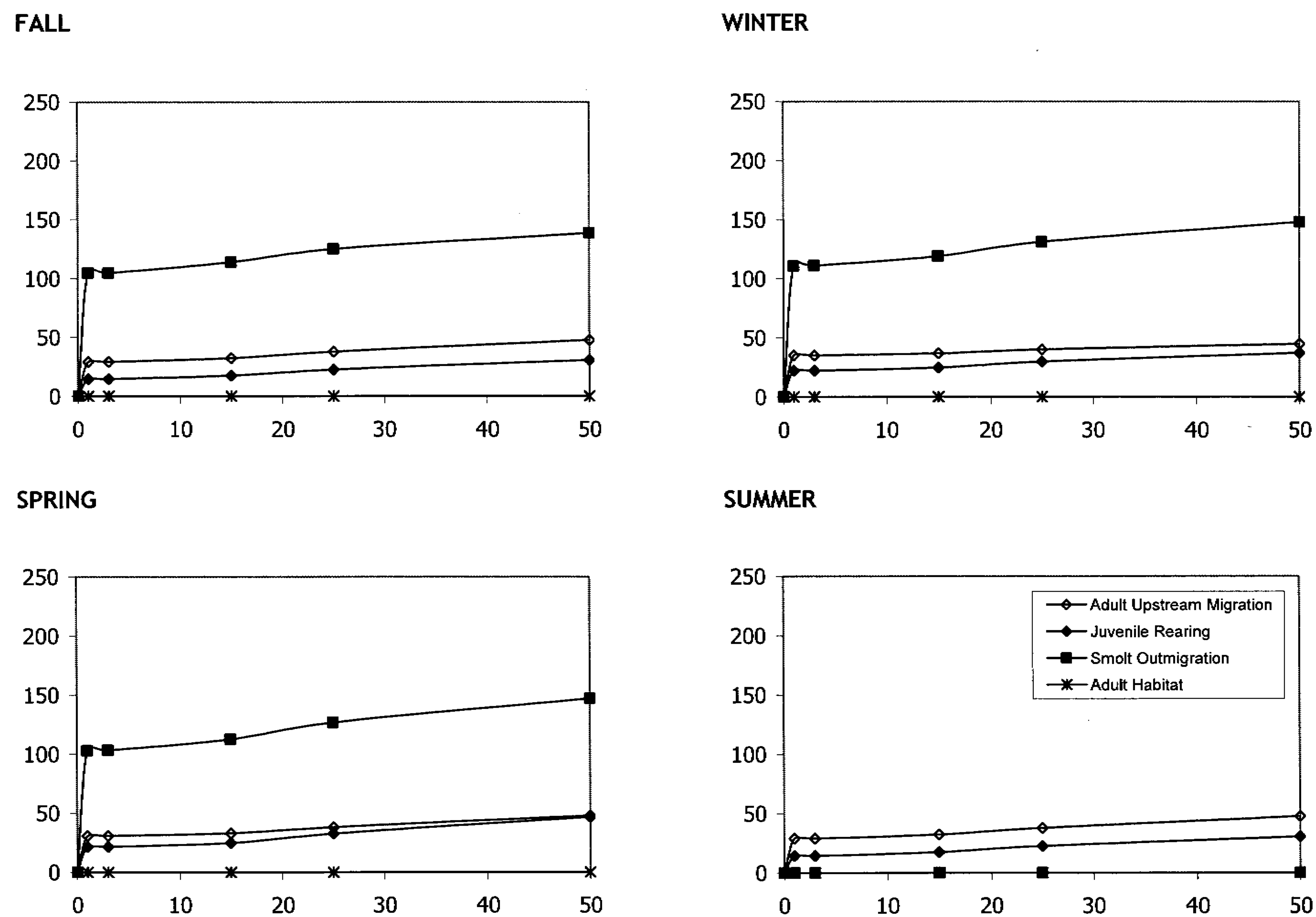


Figure B-4. SAM results showing bank-line weighted relative response (feet) for Chinook salmon (Winter-run shown) at RM 34.5.

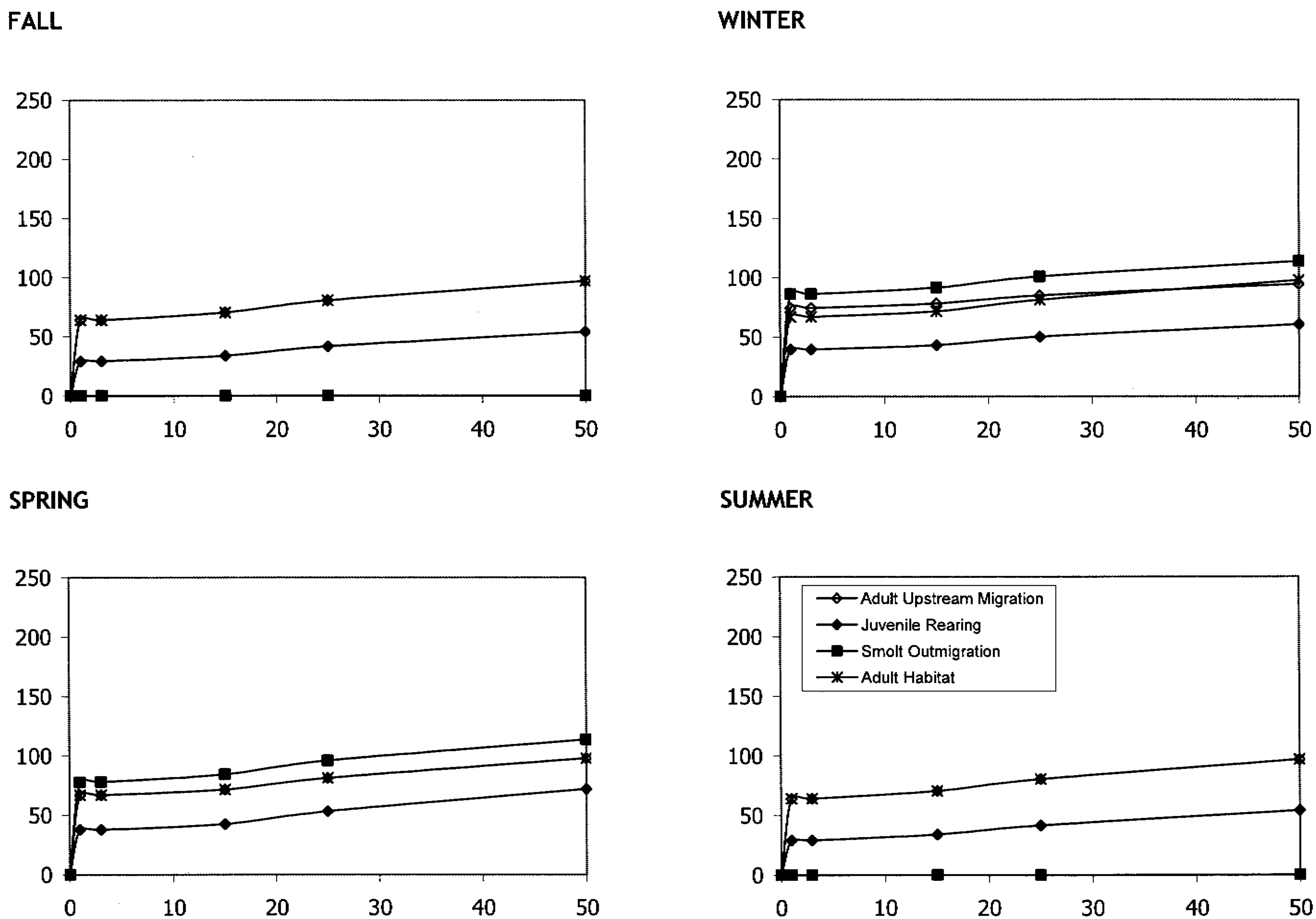


Figure B-5. SAM results showing bank-line weighted relative response (feet) for Central Valley steelhead at RM 34.5.

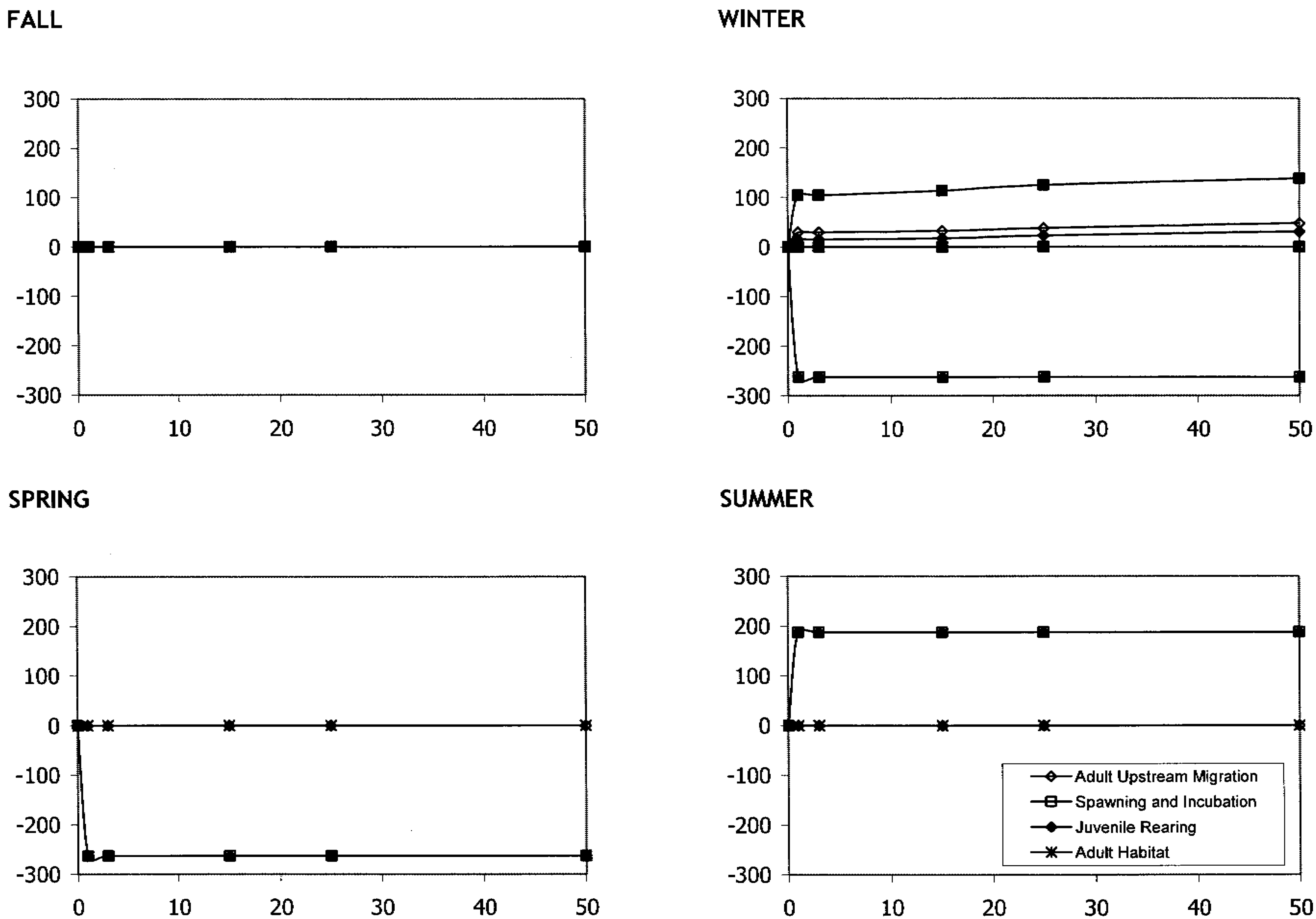


Figure B-6. SAM results showing bank-line weighted relative response (feet) for Delta smelt at RM 34.5.

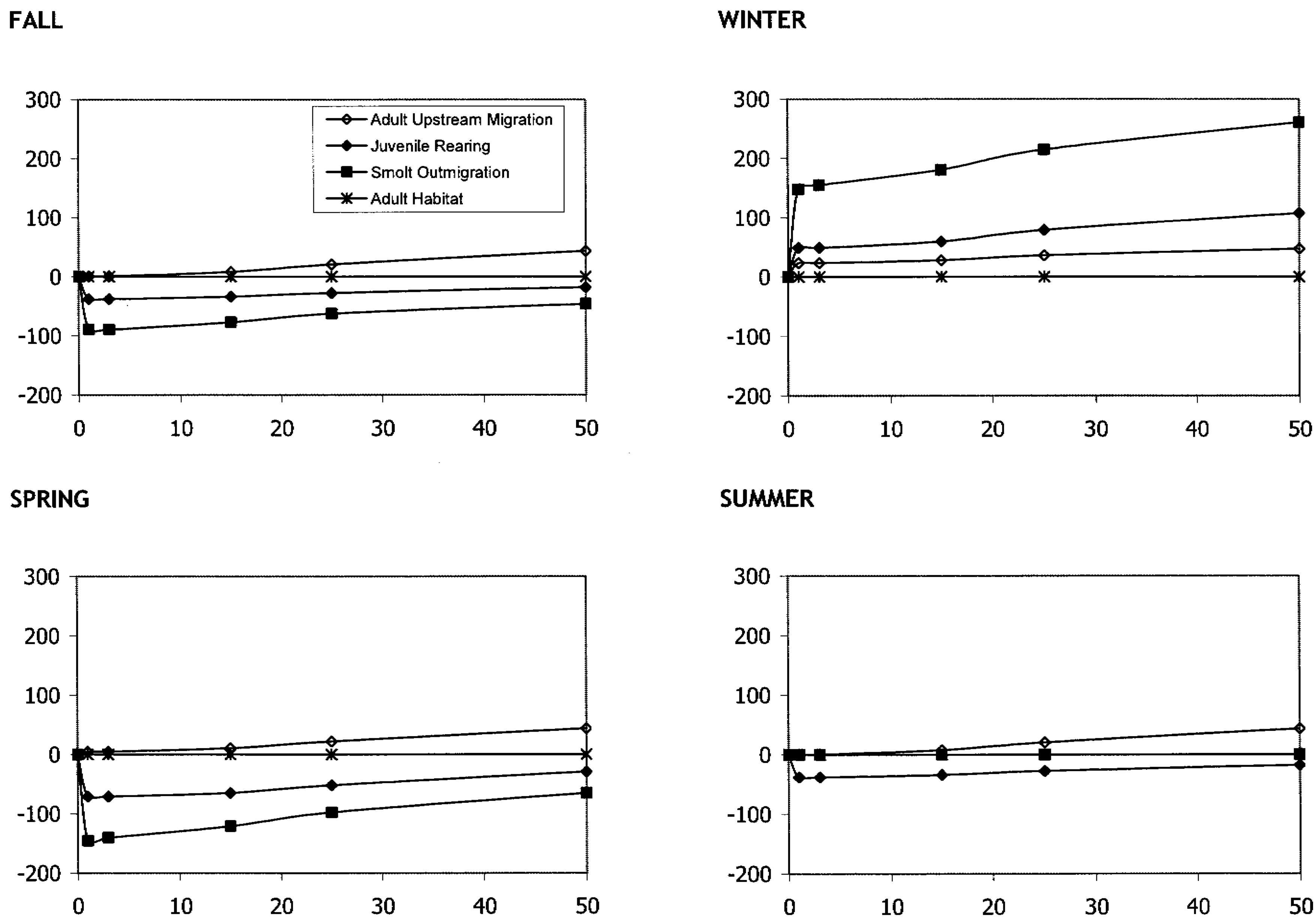


Figure B-7. SAM results showing bank-line weighted relative response (feet) for Chinook salmon (Winter-run shown) at RM 72.2.

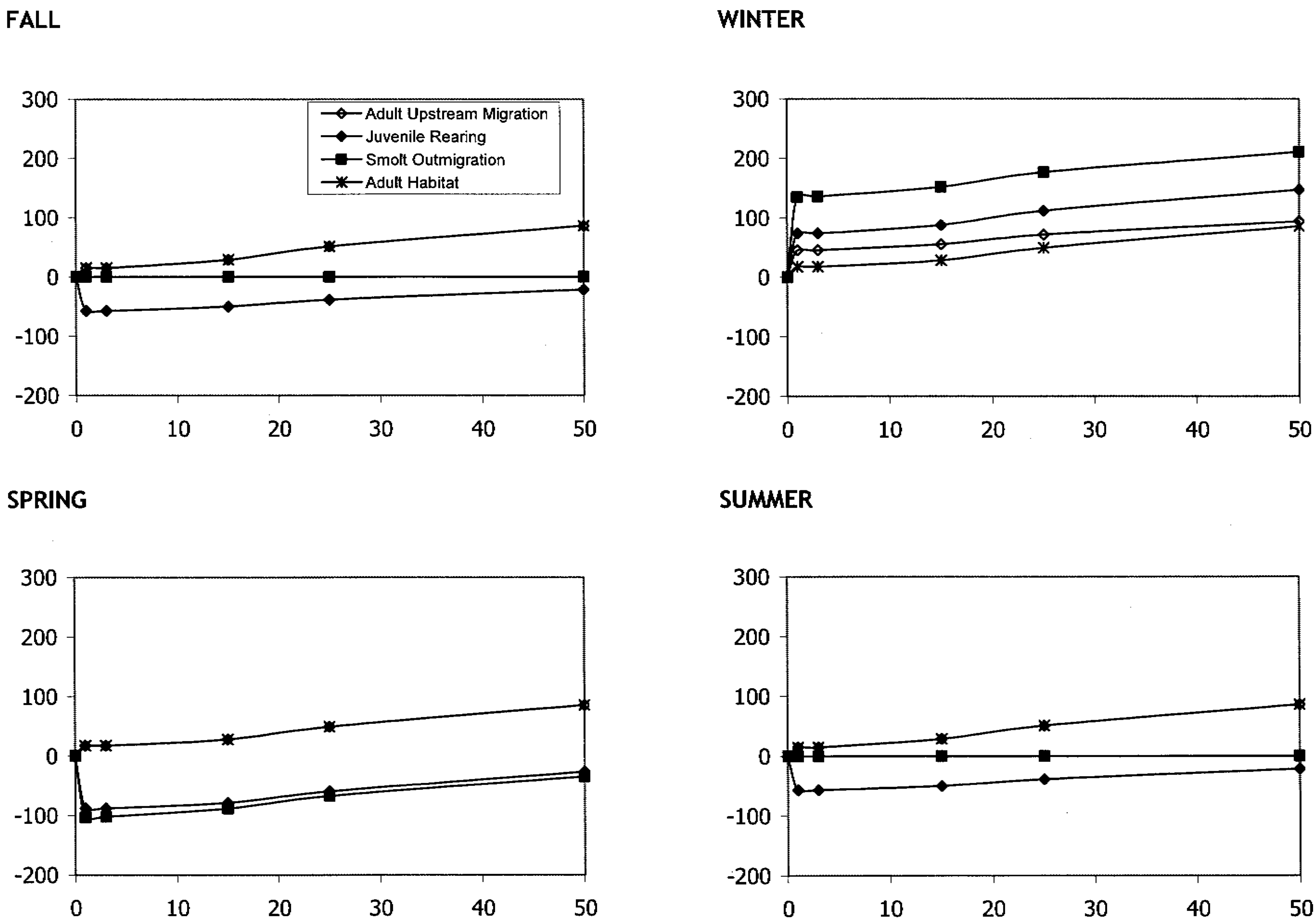


Figure B-8. SAM results showing bank-line weighted relative response (feet) for Central Valley steelhead at RM 72.2.

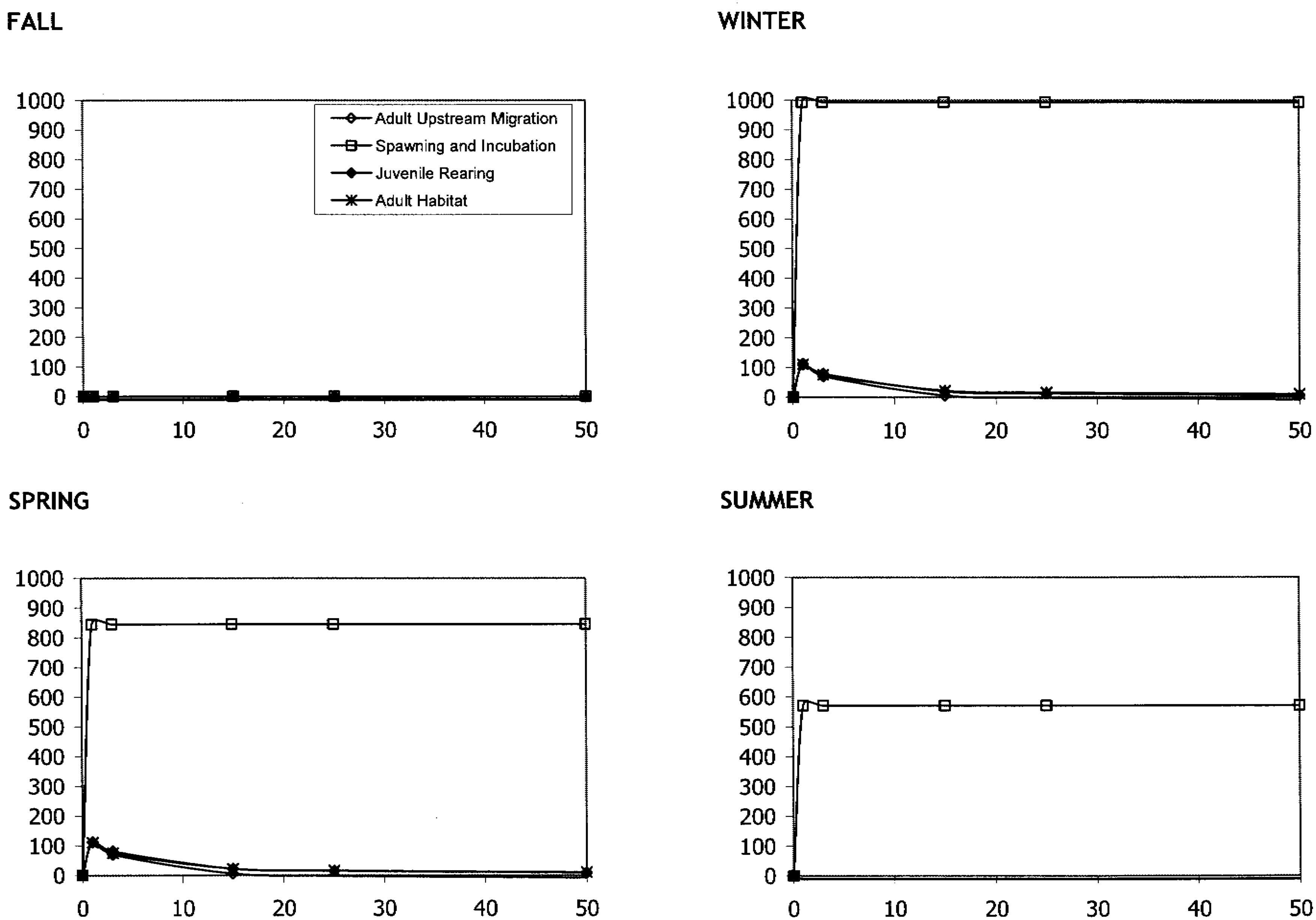


Figure B-9. SAM results showing bank-line weighted relative response (feet) for Delta smelt at RM 72.2.

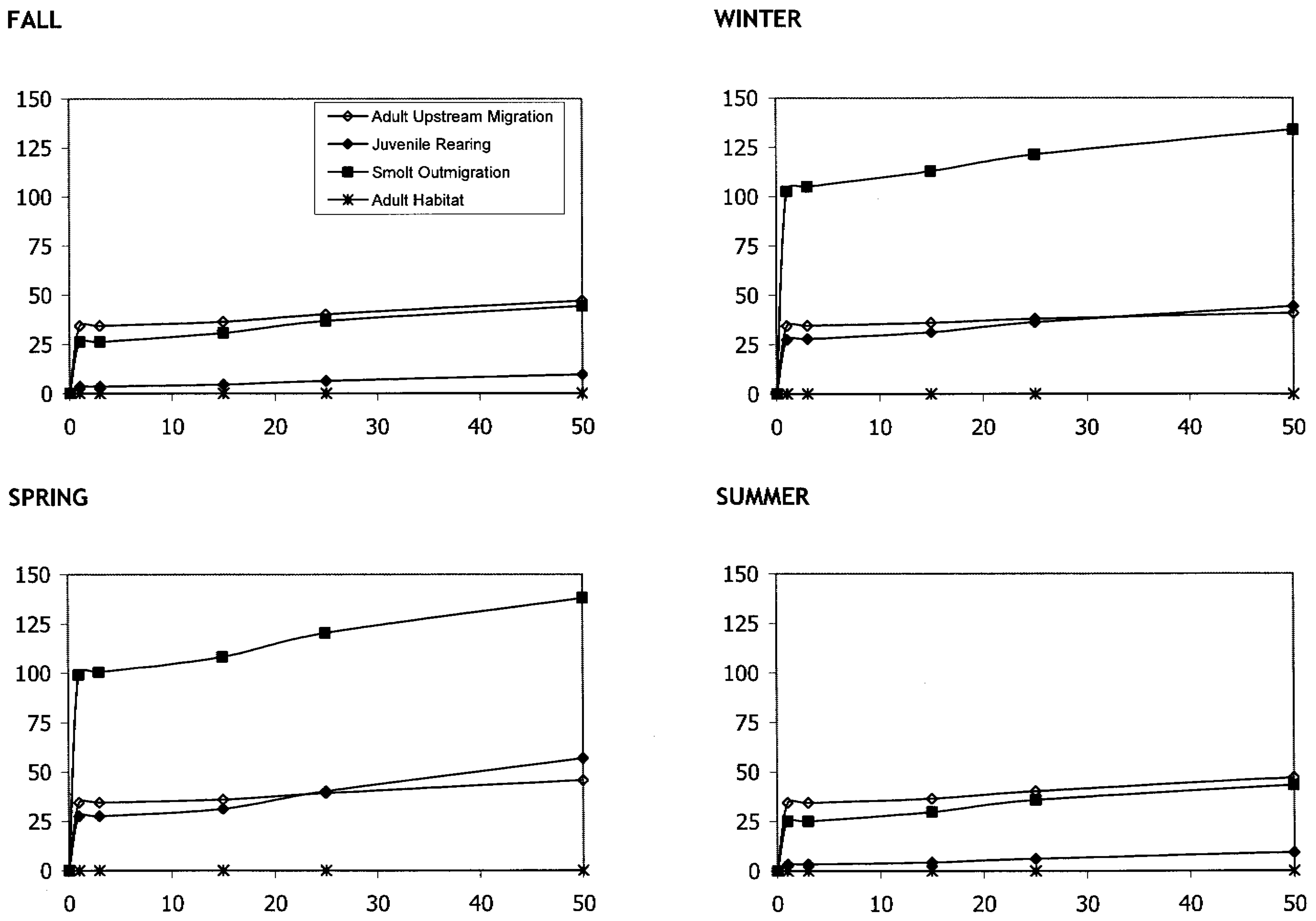


Figure B-10. SAM results showing bank-line weighted relative response (feet) for Chinook salmon (Winter-run shown) at RM 99.3.

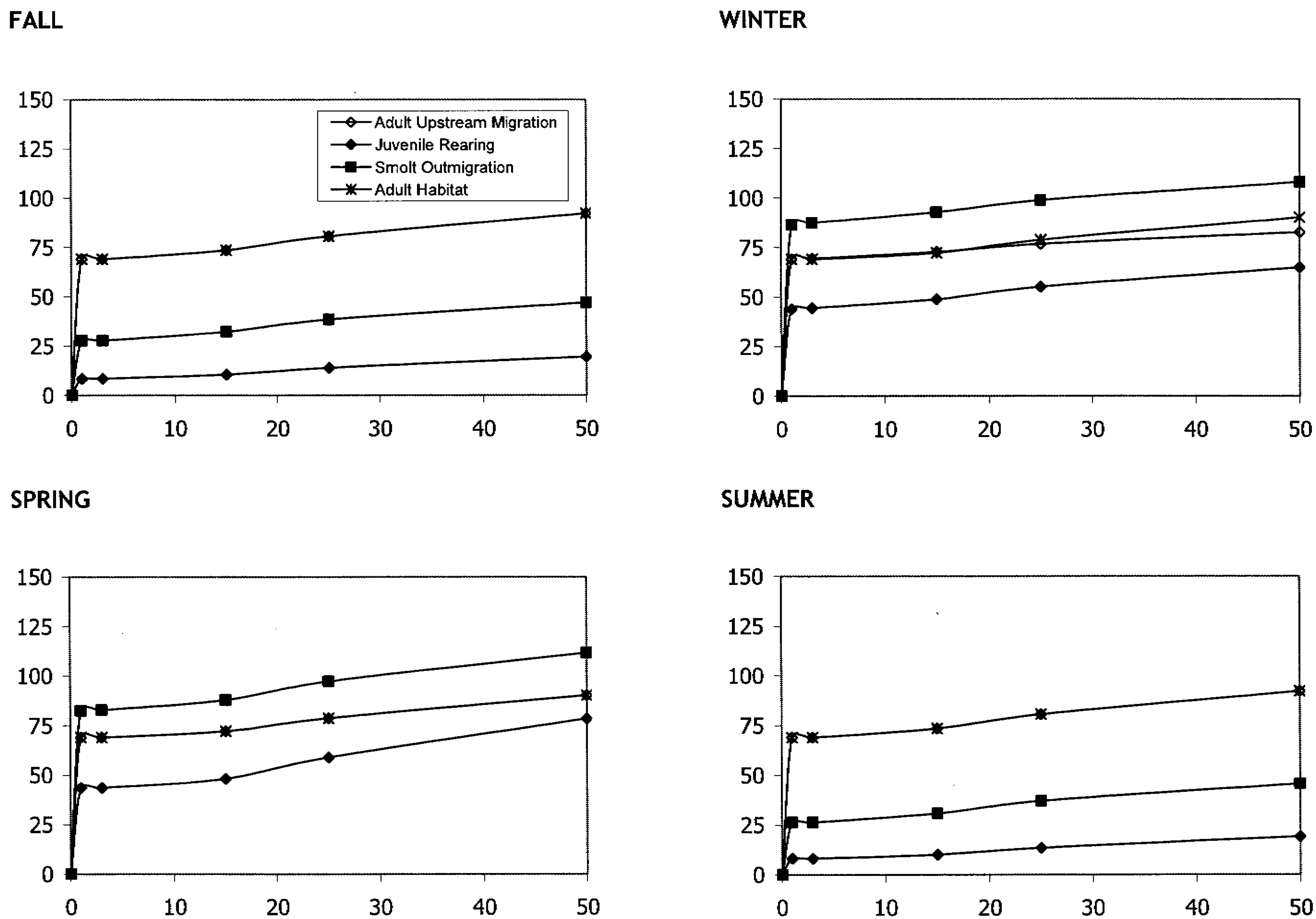


Figure B-11. SAM results showing bank-line weighted relative response (feet) for Central Valley steelhead at RM 99.3.

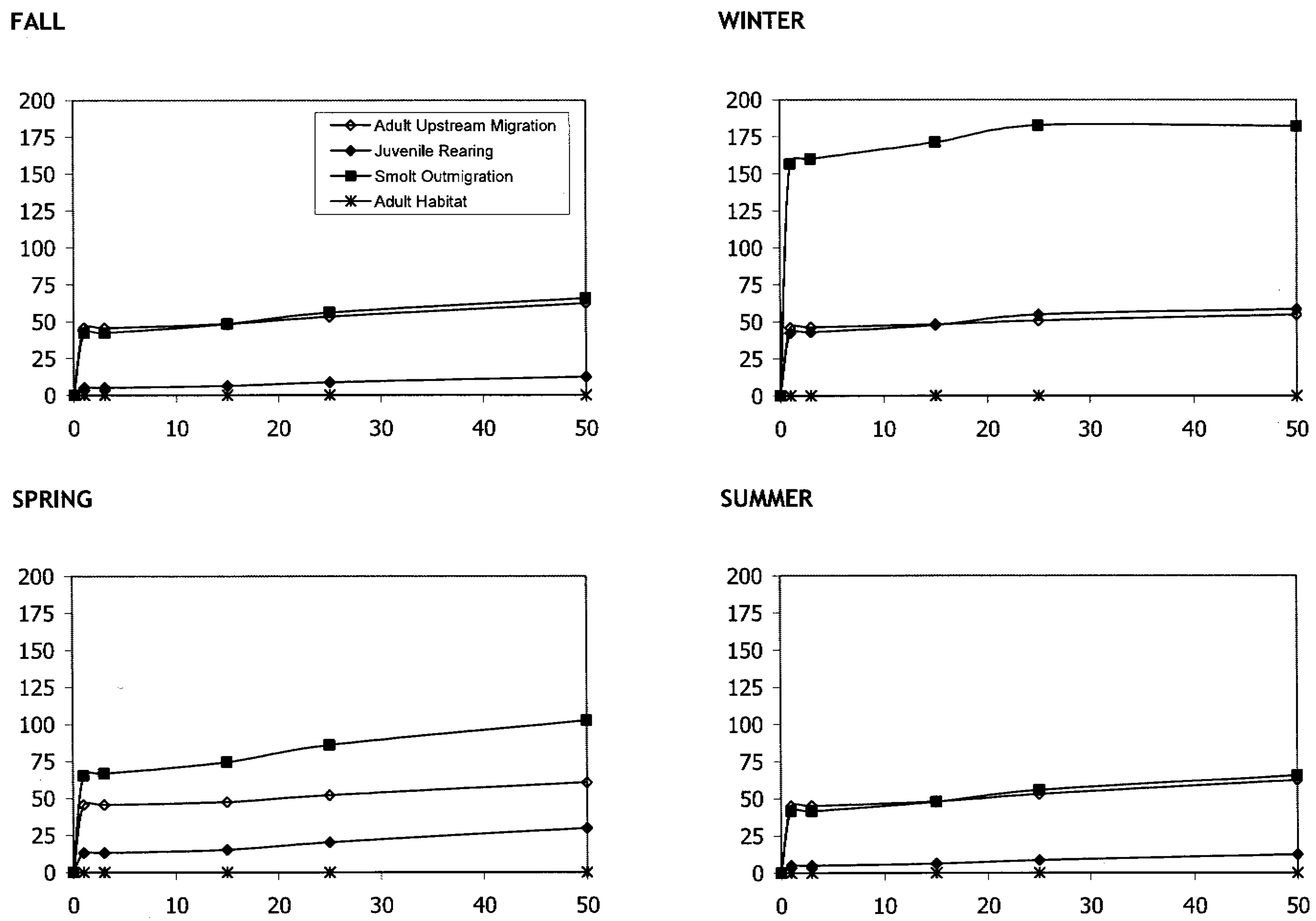


Figure B-12. SAM results showing bank-line weighted relative response (feet) for Chinook salmon (Winter-run shown) at RM 123.5.

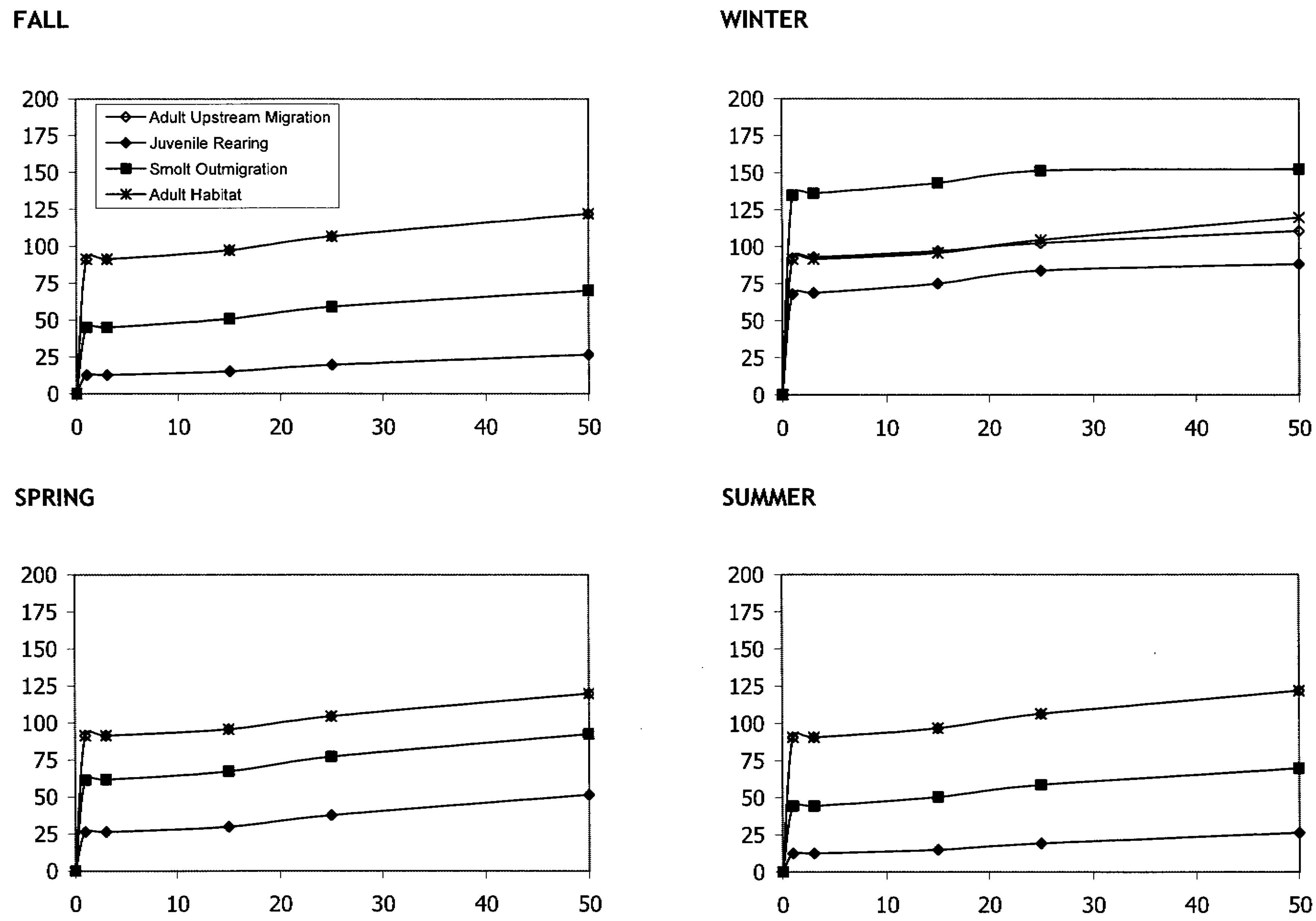


Figure B-13. SAM results showing bank-line weighted relative response (feet) for Central Valley steelhead at RM 123.5.

Attachment D
DWR Sites SAM Results

Table 1a. Site: Sacramento River 20.8L – SAM Input Values for Existing Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.3	3.3
Water Surface Elevation During 2-year Flood (Q_2)	na	7.6
Q_2 ½-width	na	243
Shoreline Site Length (feet) (L)	663	663
Channel ½-Width (feet) (W)	231	235
Wetted Area (square feet) (LxW)	153,153	155,805
Bank Slope (dW:dH) at 0-3 ft depth	12.5:1	12.5:1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.03:1
Bank Substrate Size (D_{50} in inches)	1.6 [a]	1.6 [a]
Instream Structure (% shoreline)	69	69
Vegetation (% shoreline)	0	88
Shade (% shoreline)	82	82

[a] Corps longitudinal types: 92% of natural bank and 8% of large riprap.

Table 1b. Site: Sacramento River 20.8L – SAM Input Values for With-Project Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.3	3.3
Water Surface Elevation During 2-year Flood (Q_2)	na	7.6
Q_2 ½-width	na	233
Shoreline Site Length (feet) (L)	663	663
Channel ½-Width (feet) (W)	na	206
Wetted Area (square feet) (LxW)	Same as pre-project	
Bank Slope (dW:dH) at 0-3 ft depth	1.5:1	3.5:1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.13:1
Bank Substrate Size (D_{50} in inches)	11.5	5.8
Instream Structure (% shoreline)		
Year 1	69	69
Year 5	69	69
Year 15	69	69
Year 25	34	34
Year 50	34	34

Vegetation (% shoreline)		
Year 1	0	8
Year 5	0	15
Year 15	0	30
Year 25	0	40
Year 50	0	40
Shade (% shoreline)		
Year 1	0	0
Year 5	0	10
Year 15	0	20
Year 25	0	27
Year 50	0	27

RM 20.8 WRI Values (area weighted - square feet)

Chinook Salmon

Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	-6433.80	-11504.22	-16720.78	-23044.37
5	-8149.48	-12951.10	-21179.66	-24890.49
15	-12438.68	-16568.30	-32326.85	-29505.79
25	-12652.37	-15113.28	-33205.83	-25421.43
50	-12865.29	-13922.12	-34406.45	-22327.49

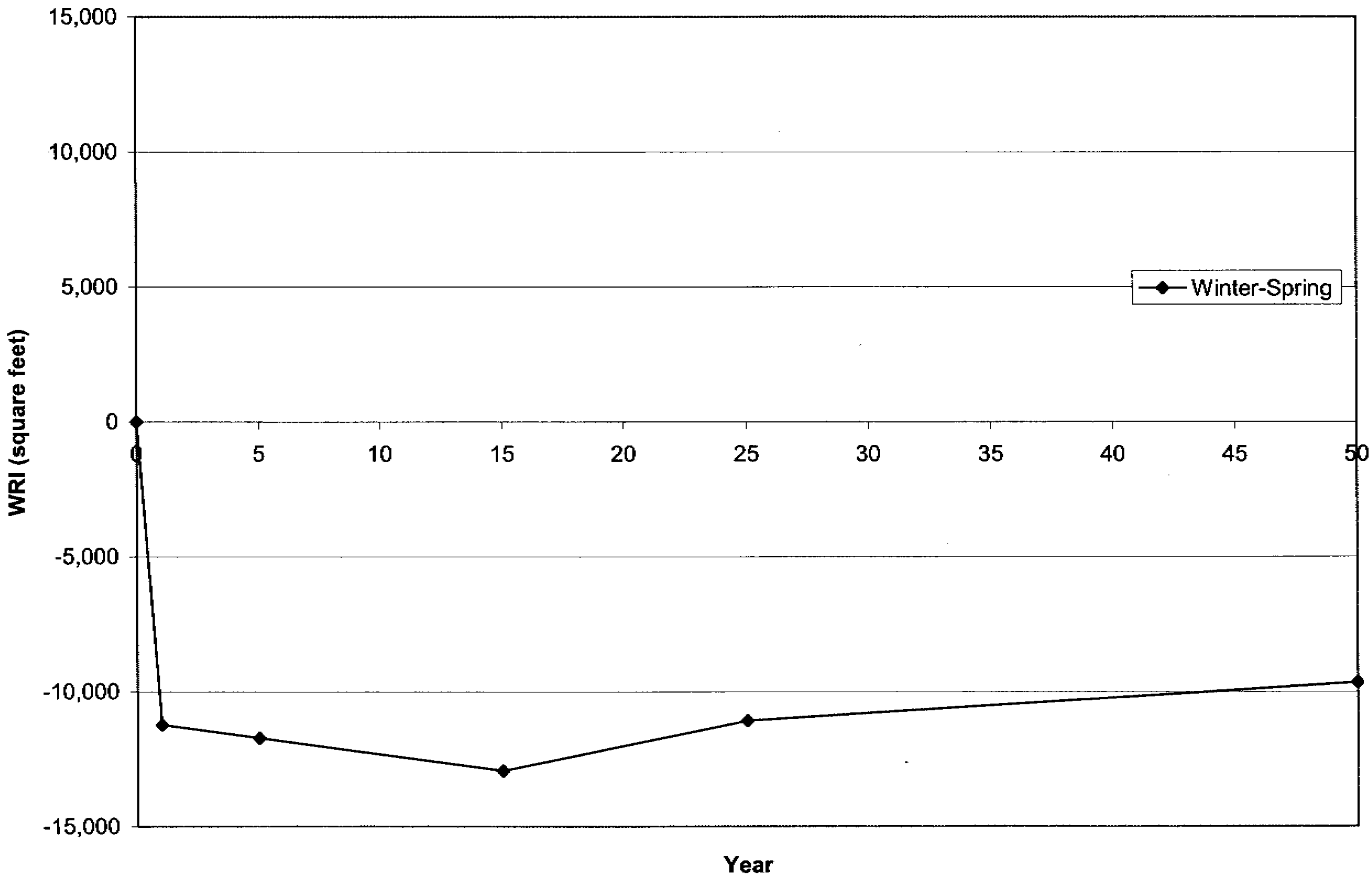
Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	-17209.76	-7566.06
5	-18395.07	-8244.50
15	-21358.33	-9940.59
25	-18010.06	-8986.39
50	-15063.35	-8376.02

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	-11233.07
5	-11720.05
15	-12937.48
25	-11084.27
50	-9653.74

Delta Smelt Spawning and Incubation
RM 20.8



RM 20.8 WRI Values (bankline weighted - feet)

Chinook Salmon

Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	-27.85	-48.95	-72.38	-98.06
5	-35.28	-55.11	-91.69	-105.92
15	-53.85	-70.50	-139.94	-125.56
25	-54.77	-64.31	-143.75	-108.18
50	-55.69	-59.24	-148.95	-95.01

Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	-61.22	-73.23
5	-68.08	-78.28
15	-85.22	-90.89
25	-77.34	-76.64
50	-71.30	-64.10

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	-47.80
5	-49.87
15	-55.05
25	-47.17
50	-41.08

Delta Smelt Spawning and Incubation
RM 20.8

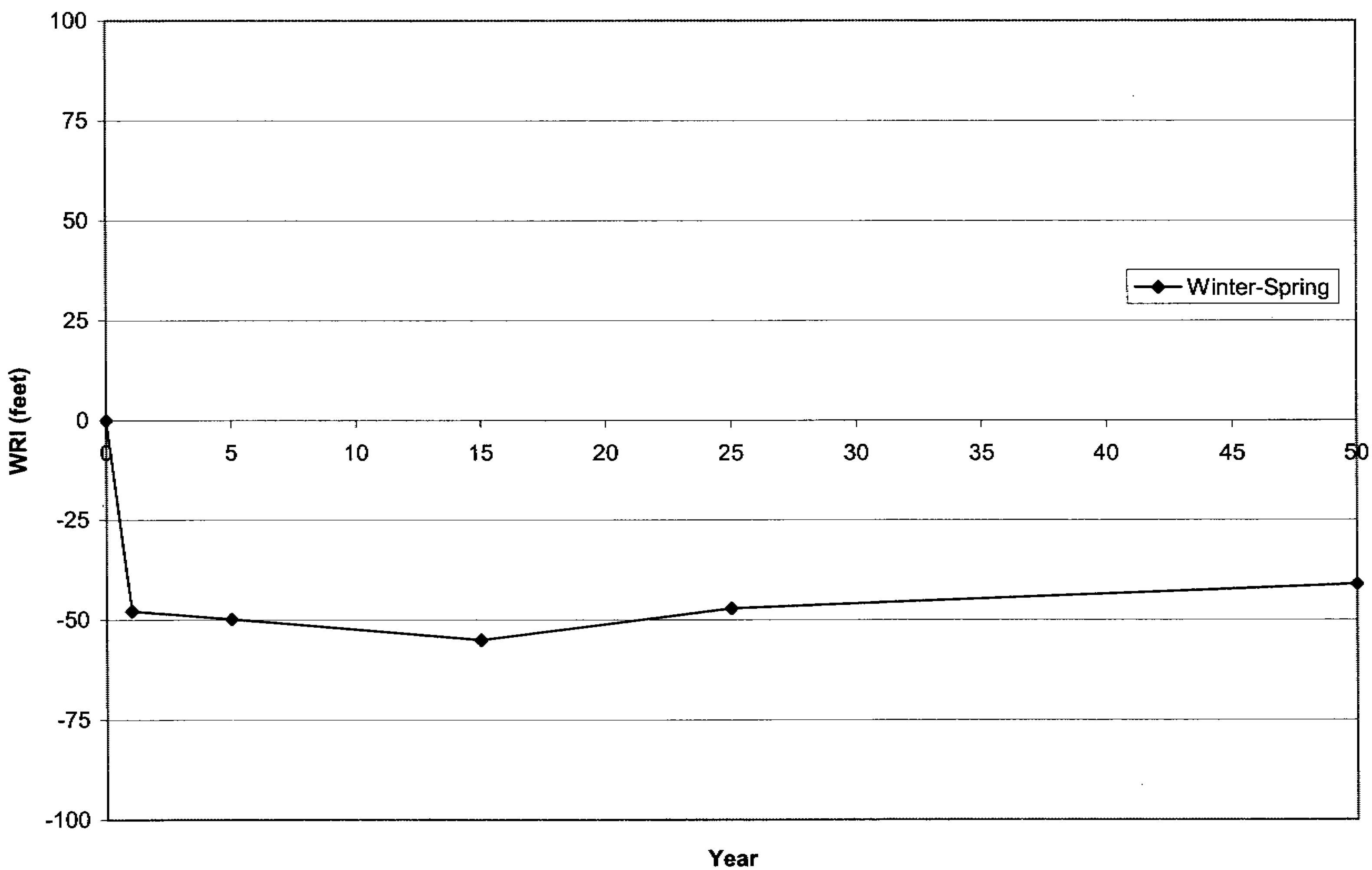


Table 2a. Site: Sacramento River 26.5L – SAM Input Values for Existing Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.6	4.1
Water Surface Elevation During 2-year Flood (Q_2)	na	9.3
Q_2 ½-width	na	194
Shoreline Site Length (feet) (L)	837	837
Channel ½-Width (feet) (W)	186.5	189
Wetted Area (square feet) (LxW)	156,101	158,193
Bank Slope (dW:dH) at 0-3 ft depth	1:1	1.1:1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.03
Bank Substrate Size (D_{50} in inches)	1.6" [a]	1.6" [a]
Instream Structure (% shoreline)	5	5
Vegetation (% shoreline)	0	88
Shade (% shoreline)	47	47

[a] Corps longitudinal types: 92% natural bank and 8% large riprap.

Table 2b. Site: Sacramento River 26.5L – SAM Input Values for With-Project Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.6	4.1
Water Surface Elevation During 2-year Flood (Q_2)	na	9.3
Q_2 ½-width	na	170
Shoreline Site Length (feet) (L)	837	837
Channel ½-Width (feet) (W)	147	150
Wetted Area (square feet) (LxW)	Same as pre-project	
Bank Slope (dW:dH) at 0-3 ft depth	2:1	3.5:1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.13
Bank Substrate Size (D_{50} in inches)	11.5	5.8
Instream Structure (% shoreline)		
Year 1	5	5
Year 5	5	5
Year 15	5	5
Year 25	2	2
Year 50	2	2

Vegetation (% shoreline)		
Year 1	0	8
Year 5	0	15
Year 15	0	30
Year 25	0	40
Year 50	0	40
Shade (% shoreline)		
Year 1	0	0
Year 5	0	10
Year 15	0	45
Year 25	0	52
Year 50	0	52

RM 26.5 WRI Values (area weighted - square feet)

Chinook Salmon

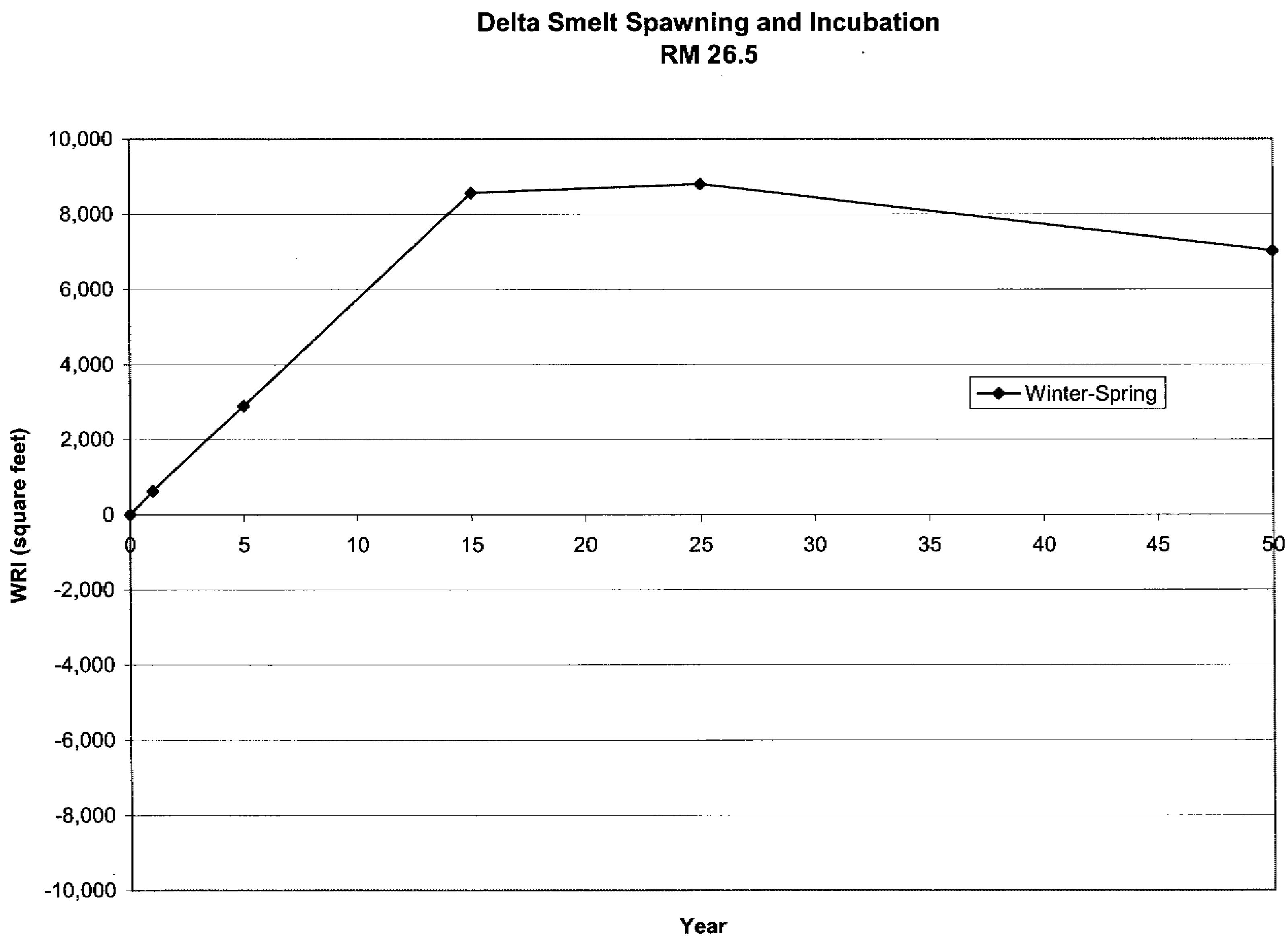
	Juvenile Rearing		Smolt Migration	
Year	Fall	Winter-Spring	Fall	Winter-Spring
0	0.00	0.00	0.00	0.00
1	-1154.65	-1710.34	-6595.28	-9385.98
5	-1462.56	-1042.85	-8354.02	-8334.90
15	-2232.33	625.86	-12750.88	-5707.19
25	-2293.04	2058.50	-13219.71	-1730.29
50	-2375.96	2898.97	-13937.52	1057.28

Steelhead

	Juvenile Rearing	Smolt Migration
Year	Winter-Spring	Winter-Spring
0	0.00	0.00
1	-2878.42	-7152.78
5	-1921.65	-5758.98
15	470.28	-2274.47
25	2562.57	1189.71
50	3813.42	3356.92

Delta smelt

	Spawning/Incubation
Year	Winter-Spring
0	0.00
1	636.18
5	2900.75
15	8562.18
25	8796.18
50	7029.61


Delta Smelt Spawning and Incubation
RM 26.5
10,000
8,000
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
-10,000
WRI (square feet)
0
5
10
15
20
25
30
35
40
45
50
Year
Winter-Spring

RM 26.5 WRI Values (bankline weighted - feet)

Chinook Salmon

Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	-6.19	-9.05	-35.36	-49.66
5	-7.84	-5.52	-44.79	-44.10
15	-11.97	3.31	-68.37	-30.20
25	-12.30	10.89	-70.88	-9.15
50	-12.74	15.34	-74.73	5.59

Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	-15.23	-37.85
5	-10.17	-30.47
15	2.49	-12.03
25	13.56	6.29
50	20.18	17.76

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	3.37
5	15.35
15	45.30
25	46.54
50	37.19

Delta Smelt Spawning and Incubation
RM 26.5

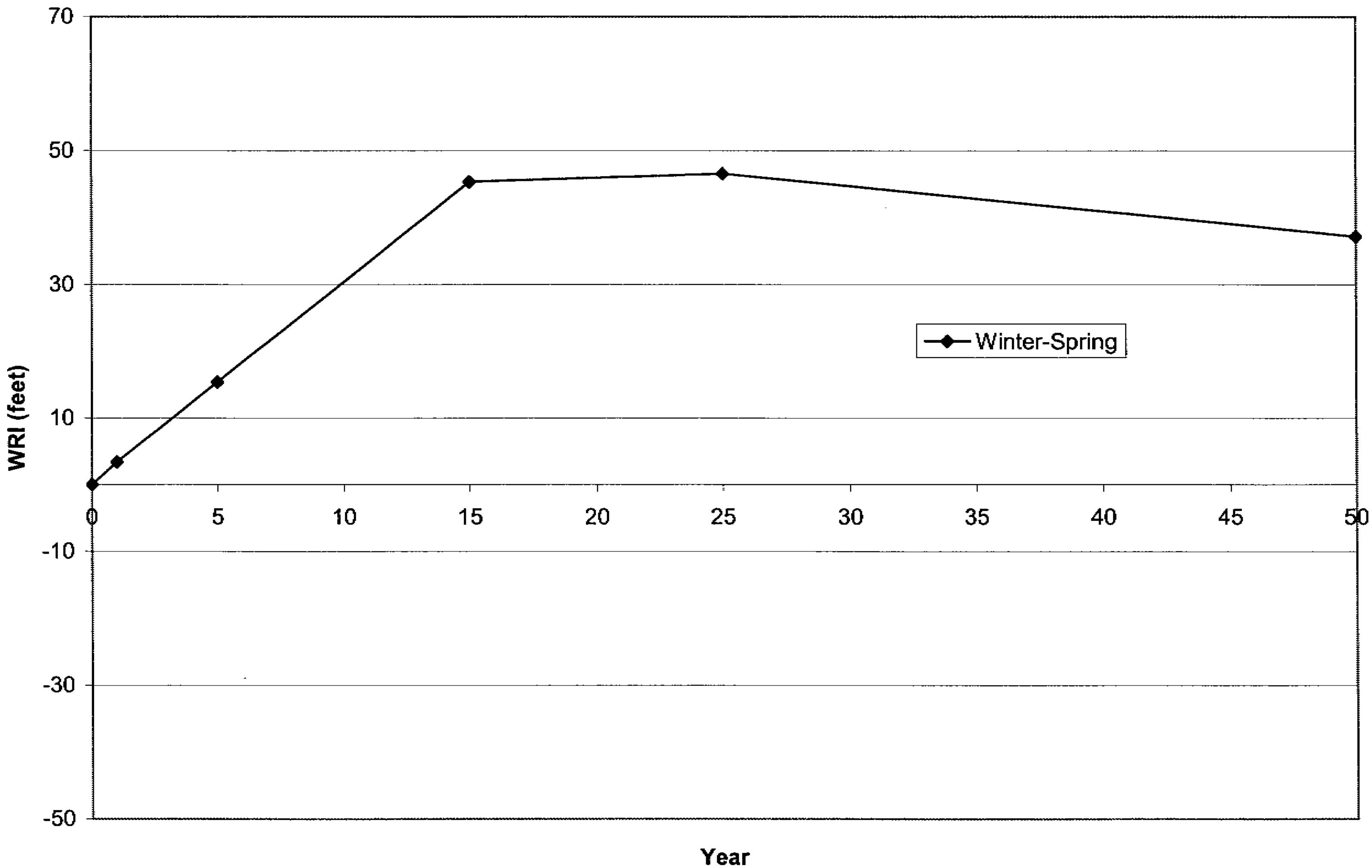


Table 3a. Site: Sacramento River 32.5 R – SAM Input Values for Existing Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.9	4.9
Water Surface Elevation During 2-year Flood (Q_2)	na	11.3
Q_2 ½-width	na	232
Shoreline Site Length (feet) (L)	2,350	2,350
Channel ½-Width (feet) (W)	220	222
Wetted Area (square feet) (LxW)	517,000	521,700
Bank Slope (dW:dH) at 0-3 ft depth	1.2 : 1	1.2 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.05
Bank Substrate Size (D_{50} in inches)	4.6" [a]	4.6" [a]
Instream Structure (% shoreline)	59	59
Vegetation (% shoreline)	0	88
Shade (% shoreline)	68	68

[a] Corps longitudinal types: 23% large riprap and 77% natural bank.

Table 3b. Site: Sacramento River 32.5 R – SAM Input Values for With-Project Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.9	4.9
Water Surface Elevation During 2-year Flood (Q_2)	na	11.3
Q_2 ½-width	na	218
Shoreline Site Length (feet) (L)	2,350	2,350
Channel ½-Width (feet) (W)	180.5	184
Wetted Area (square feet) (LxW)	Same as pre-project	
Bank Slope (dW:dH) at 0-3 ft depth	2.4 : 1	4.9:1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.18
Bank Substrate Size (D_{50} in inches)	5.8	5.8
Instream Structure (% shoreline		
Year 1	40	40
Year 5	40	40
Year 15	40	40
Year 25	20	20
Year 50	20	20

Vegetation (% shoreline)		
Year 1	0	15
Year 5	0	30
Year 15	0	60
Year 25	0	80
Year 50	0	80
Shade (% shoreline)		
Year 1	0	0
Year 5	0	20
Year 15	0	40
Year 25	0	53
Year 50	0	53

RM 32.5 WRI Values (area weighted - square feet)

Chinook Salmon

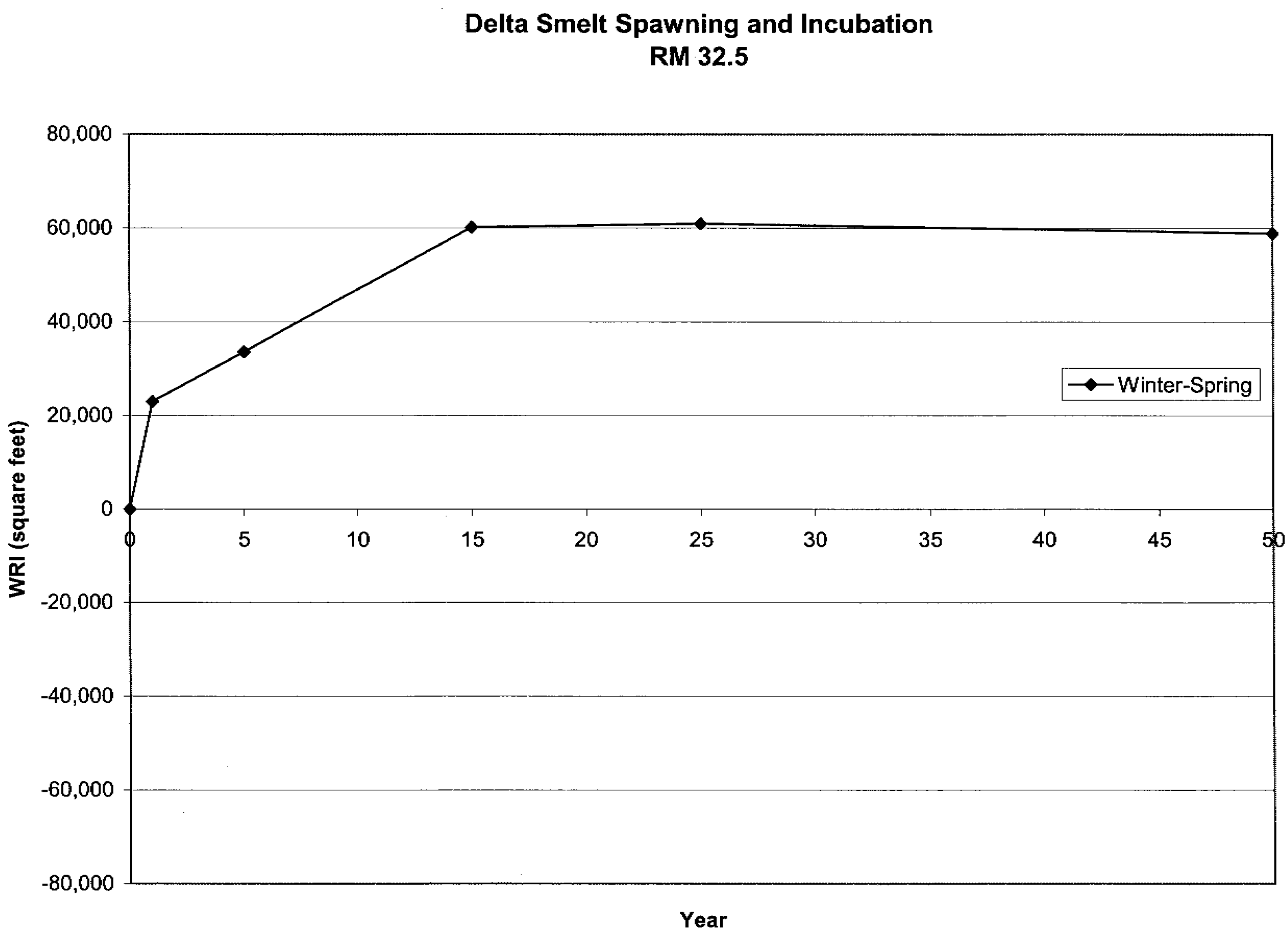
Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	-6510.77	-9742.83	-15832.70	-33665.96
5	-8246.98	-3611.00	-20054.75	-22835.87
15	-12587.49	11718.57	-30609.89	4239.36
25	-13260.74	16716.85	-34023.17	13388.59
50	-14390.22	17764.85	-40321.97	14021.69

Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	-14337.88	-18832.28
5	-7087.43	-9400.88
15	11038.72	14177.63
25	16977.05	21216.76
50	18097.87	23441.43

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	22968.21
5	33597.27
15	60169.93
25	60929.34
50	58908.70


Delta Smelt Spawning and Incubation
RM 32.5
WRI (square feet)
80,000
60,000
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
0
5
10
15
20
25
30
35
40
45
50
Year
Winter-Spring

RM 32.5 WRI Values (bankline weighted - feet)

Chinook Salmon

	Juvenile Rearing		Smolt Migration	
Year	Fall	Winter-Spring	Fall	Winter-Spring
0	0.00	0.00	0.00	0.00
1	-29.59	-43.89	-71.97	-151.65
5	-37.49	-16.27	-91.16	-102.86
15	-57.22	52.79	-139.14	19.10
25	-60.28	75.30	-154.65	60.31
50	-65.41	80.02	-183.28	63.16

Steelhead

	Juvenile Rearing	Smolt Migration
Year	Winter-Spring	Winter-Spring
0	0.00	0.00
1	-64.59	-84.83
5	-31.93	-42.35
15	49.72	63.86
25	76.47	95.57
50	81.52	105.59

Delta smelt

	Spawning/Incubation
Year	Winter-Spring
0	0.00
1	103.46
5	151.34
15	271.04
25	274.46
50	265.35

Delta Smelt Spawning and Incubation
RM 32.5

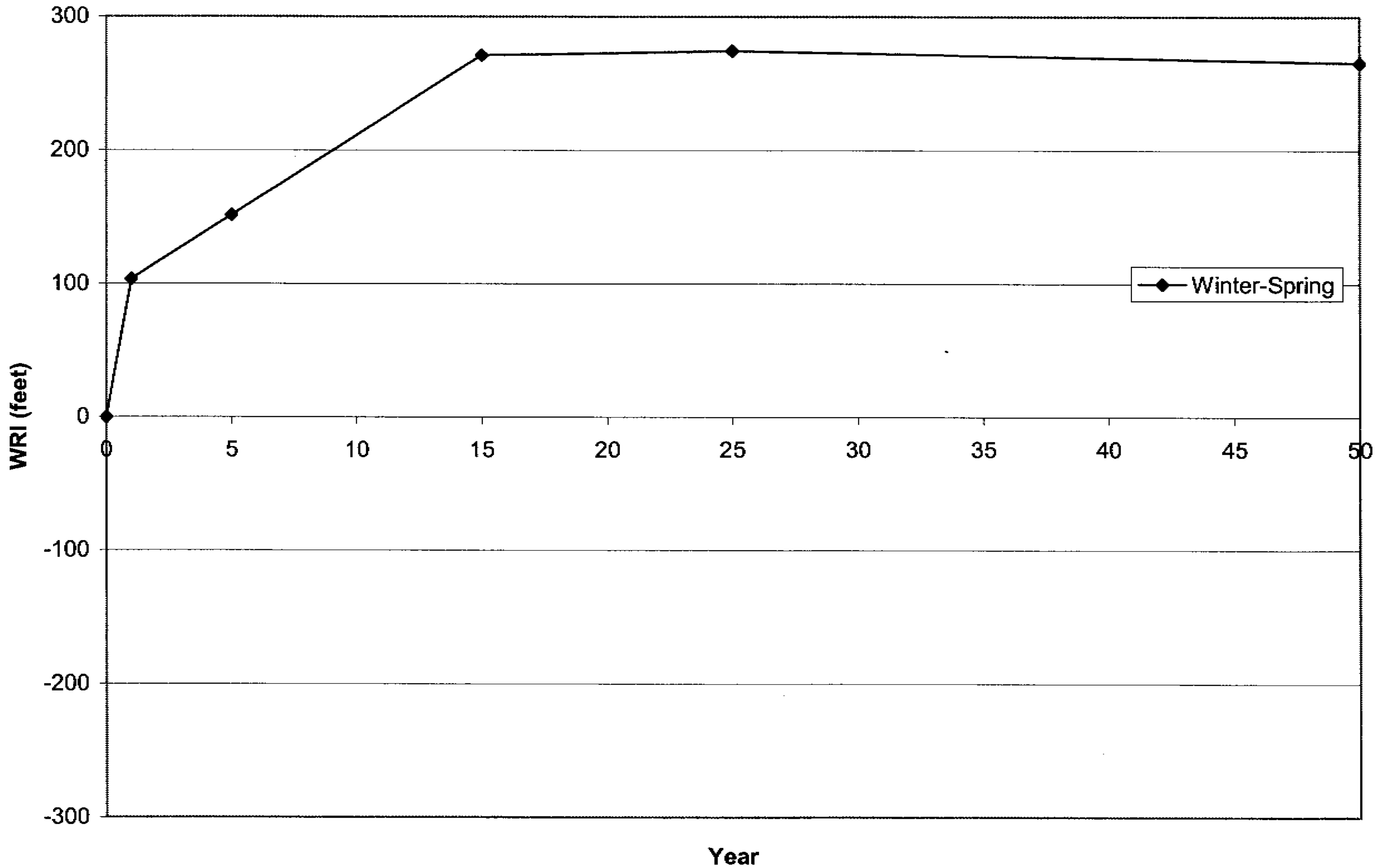


Table 4a. Site Sac 56.8 R – SAM Input Values for Existing Conditions

	Season		
	Summer-Fall	Winter	Spring
Average Water Surface Elevation (feet)	4.4	11.0	6.1
Water Surface Elevation During 2-year Flood (Q_2)	na	22.0	
Q_2 ½-width	na	308	
Shoreline Site Length (feet) (L)770	770	770	770
Channel ½-Width (feet) (W)	246	260	251
Wetted Area (square feet) (LxW)	189,420	200,200	193,270
Bank Slope (dW:dH) at 0-3 ft depth	5.1 : 1	2.1 : 1	3.5 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.20	
Bank Substrate Size (D_{50} in inches)	2[1]	2[a]	2[a]
Instream Structure (% shoreline)	68	68	68
Vegetation (% shoreline)	0	86	86
Shade (% shoreline)	46	46	46

[a] Corps longitudinal types: 10% of large riprap and 90% natural bank.

Table 4b. Site Sac 56.8 R – SAM Input Values for With-Project Conditions

	Season		
	Summer-Fall	Winter	Spring
Average Water Surface Elevation (feet)	4.4	11.0	6.1
Water Surface Elevation During 2-year Flood (Q_2)	na	22.0	
Q_2 ½-width	na	290	
Shoreline Site Length (feet) (L)	770	770	770
Channel ½-Width (feet) (W)	223	239	226
Wetted Area (square feet) (LxW)	Same as pre-project		
Bank Slope (dW:dH) at 0-3 ft depth	4.6 : 1	2.5 : 1	3.9 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.24	
Bank Substrate Size (D_{50} in inches)	0.01	0.01	0.01
Instream Structure (% shoreline)			
Year 1	23	69	46
Year 5	23	69	46
Year 15	23	69	46
Year 25	12	34	23
Year 50	12	34	23

Vegetation (% shoreline)			
Year 1	0	15	15
Year 5	0	25	25
Year 15	0	50	50
Year 25	0	70	70
Year 50	0	70	70
Shade (% shoreline)			
Year 1	0	0	0
Year 5	0	17	17
Year 15	0	33	33
Year 25	0	47	47
Year 50	0	47	47

RM 56.8 WRI Values (area weighted - square feet)

Chinook Salmon

	Juvenile Rearing			Smolt Migration		
Year	Fall	Winter	Spring	Fall	Winter	Spring
0	0.00	0.00	0.00	0.00	0.00	0.00
1	-5157.92	-7279.01	-9150.66	-12373.65	-19150.59	-21177.01
5	-6533.37	-6718.83	-8804.78	-15673.29	-17716.61	-20323.11
15	-9971.99	-5318.38	-7940.09	-23922.39	-14131.65	-18188.39
25	-10332.56	-3221.42	-6101.43	-25361.33	-9508.21	-14342.06
50	-10881.76	-1598.93	-5253.56	-27826.77	-6836.55	-13113.29

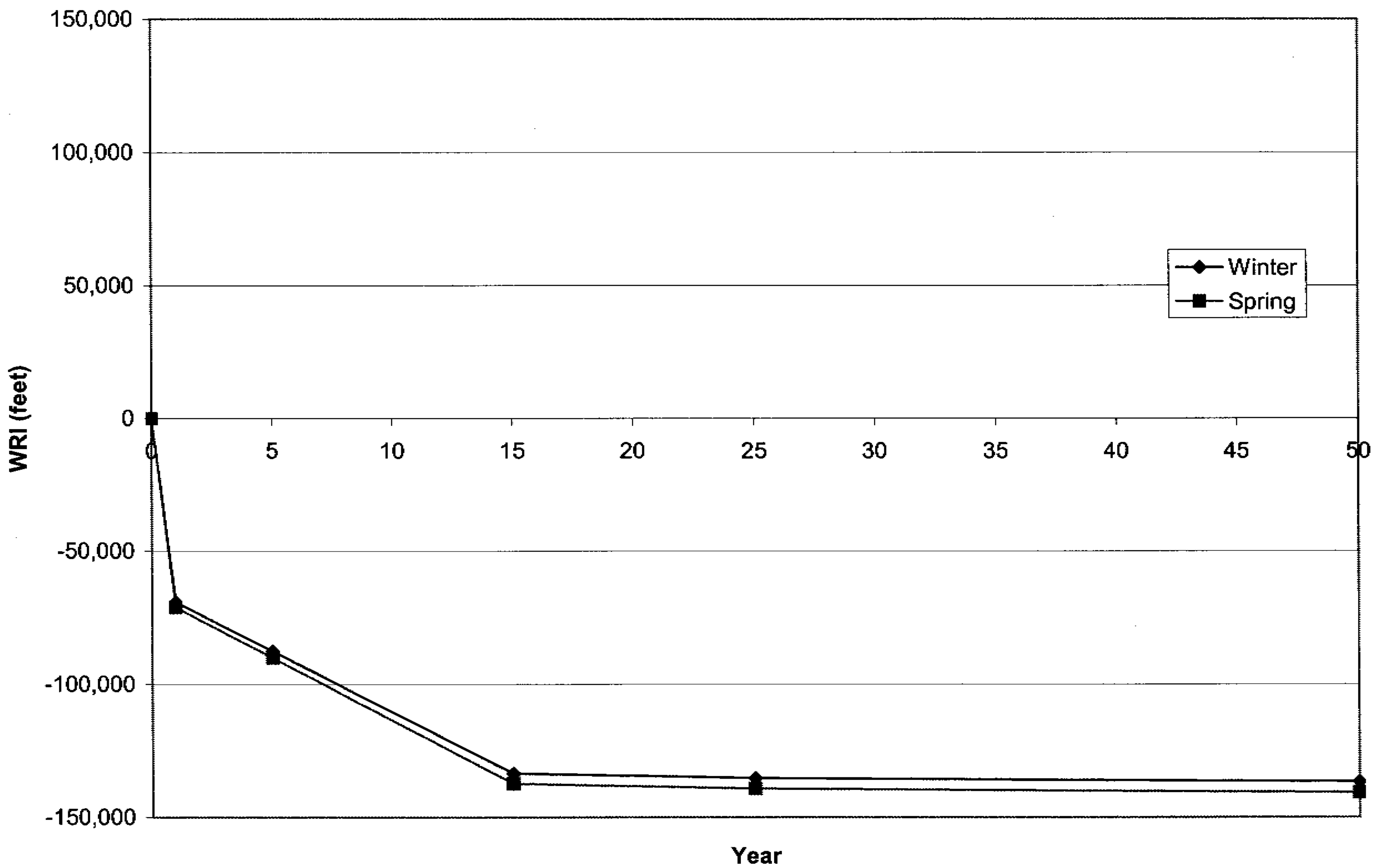
Steelhead

	Juvenile Rearing		Smolt Migration	
Year	Winter	Spring	Winter	Spring
0	0.00	0.00	0.00	0.00
1	-9783.01	-11672.31	-12994.07	-13740.48
5	-8995.16	-11186.40	-11670.59	-12620.52
15	-7025.55	-9971.64	-8361.89	-9820.62
25	-4404.56	-7764.37	-4827.60	-6853.21
50	-2491.43	-6832.91	-2111.96	-5241.98

Delta smelt

	Spawning/Incubation	
Year	Winter	Spring
0	0.00	0.00
1	-69157.53	-71161.18
5	-87540.31	-90077.21
15	-133497.25	-137367.26
25	-135306.70	-139245.82
50	-136669.18	-140680.58

Delta Smelt Spawning and Incubation
RM 56.8



RM 56.8 WRI Values (bankline weighted - feet)

Chinook Salmon

Year	Juvenile Rearing Fall	Juvenile Rearing Winter	Juvenile Rearing Spring	Smolt Migration Fall	Smolt Migration Winter	Smolt Migration Spring
0	0.00	0.00	0.00	0.00	0.00	0.00
1	-20.97	-28.00	-36.46	-50.30	-73.66	-84.37
5	-26.56	-25.84	-35.08	-63.71	-68.14	-80.97
15	-40.54	-20.46	-31.63	-97.25	-54.35	-72.46
25	-42.00	-12.39	-24.31	-103.09	-36.57	-57.14
50	-44.23	-6.15	-20.93	-113.12	-26.29	-52.24

Steelhead

Year	Juvenile Rearing Winter	Juvenile Rearing Spring	Smolt Migration Winter	Smolt Migration Spring
0	0.00	0.00	0.00	0.00
1	-37.63	-46.50	-49.98	-54.74
5	-34.60	-44.57	-44.89	-50.28
15	-27.02	-39.73	-32.16	-39.13
25	-16.94	-30.93	-18.57	-27.30
50	-9.58	-27.22	-8.12	-20.88

Delta smelt

Year	Spawning/Incubation Winter	Spawning/Incubation Spring
0	0.00	0.00
1	-265.99	-283.51
5	-336.69	-358.87
15	-513.45	-547.28
25	-520.41	-554.76
50	-525.65	-560.48

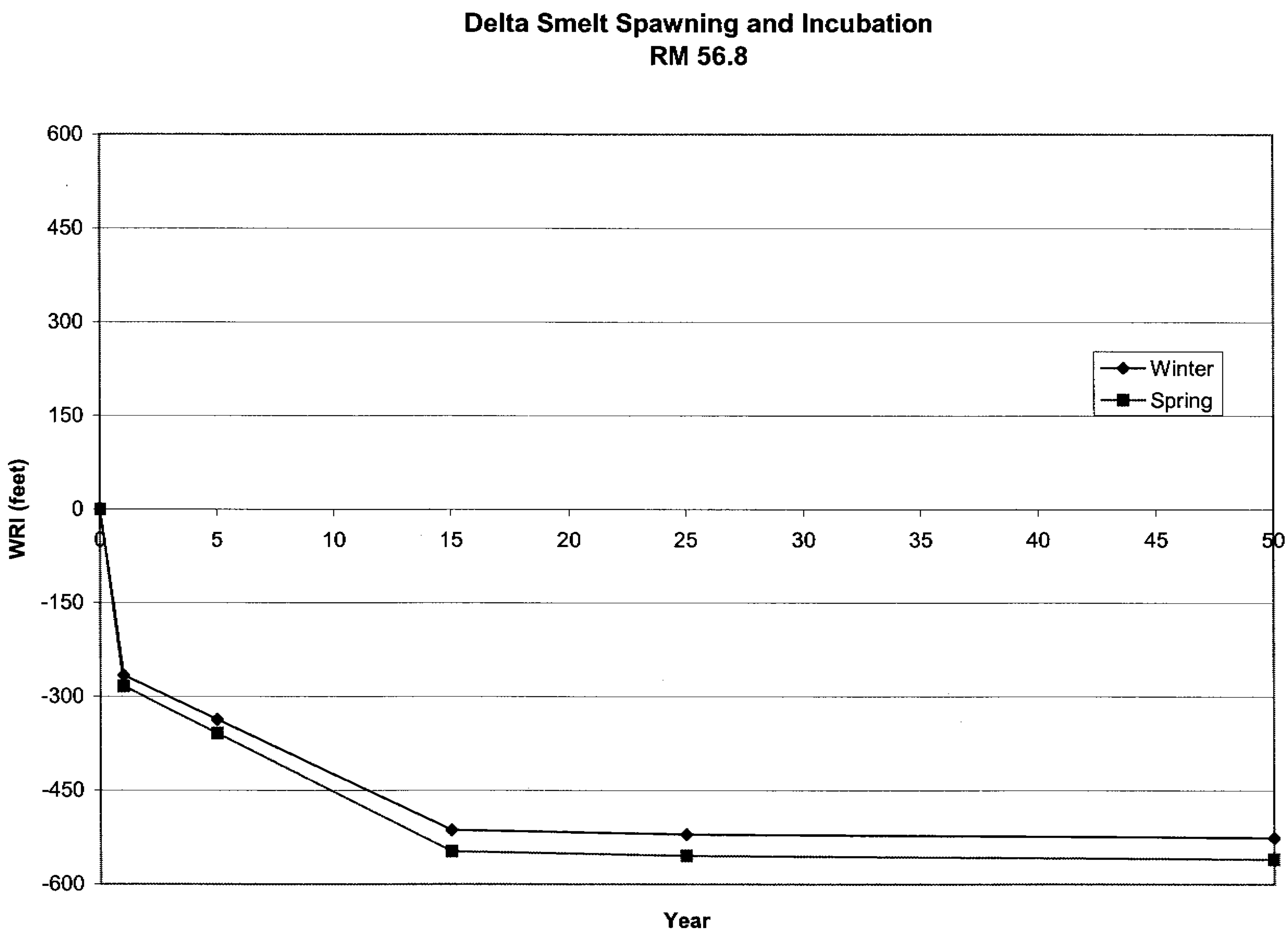

Delta Smelt Spawning and Incubation
RM 56.8
WRI (feet)
600
450
300
150
0
-150
-300
-450
-600
0
5
10
15
20
25
30
35
40
45
50
Year
Winter
Spring

Table 14a. Site: Cache Slough 16.5 L – SAM Input Values for Existing Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.1	2.7
Water Surface Elevation During 2-year Flood (Q_2)	na	6.0
Q_2 ½-width	na	159
Shoreline Site Length (feet) (L)	495	495
Channel ½-Width (feet) (W)	149	151
Wetted Area (square feet) (LxW)	73,755	74,745
Bank Slope (dW:dH) at 0-3 ft depth	4.2 : 1	3.7 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.05
Bank Substrate Size (D_{50} in inches)	0.01	0.01
Instream Structure (% shoreline)	90	90
Vegetation (% shoreline)	0	80
Shade (% shoreline)	0	0

Table 14b. Site: Cache Slough 16.5 L – SAM Input Values for With-Project Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.1	2.7
Water Surface Elevation During 2-year Flood (Q_2)	na	6.0
Q_2 ½-width	na	149
Shoreline Site Length (feet) (L)	495	495
Channel ½-Width (feet) (W)	131	137
Wetted Area (square feet) (LxW)	Same as pre-project	
Bank Slope (dW:dH) at 0-3 ft depth	2 : 1	2 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.09
Bank Substrate Size (D_{50} in inches)	11.5	11.5
Instream Structure (% shoreline)		
Year 1	90	90
Year 5	90	90
Year 15	90	90
Year 25	45	45
Year 50	45	45

Vegetation (% shoreline)		
Year 1	0	0
Year 5	0	0
Year 15	0	0
Year 25	0	0
Year 50	0	0
Shade (% shoreline)		
Year 1	0	0
Year 5	0	0
Year 15	0	50
Year 25	50	50
Year 50	50	50

Cache RM 16.5 WRI Values (area weighted - square feet)

Chinook Salmon

Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	-654.68	-1878.59	-3469.20	-9573.56
5	-829.26	-2213.45	-4394.33	-11651.80
15	-1265.71	-3050.59	-6707.13	-16847.41
25	-978.19	-2662.37	-5983.69	-15935.58
50	-381.33	-2404.68	-4421.16	-15454.25

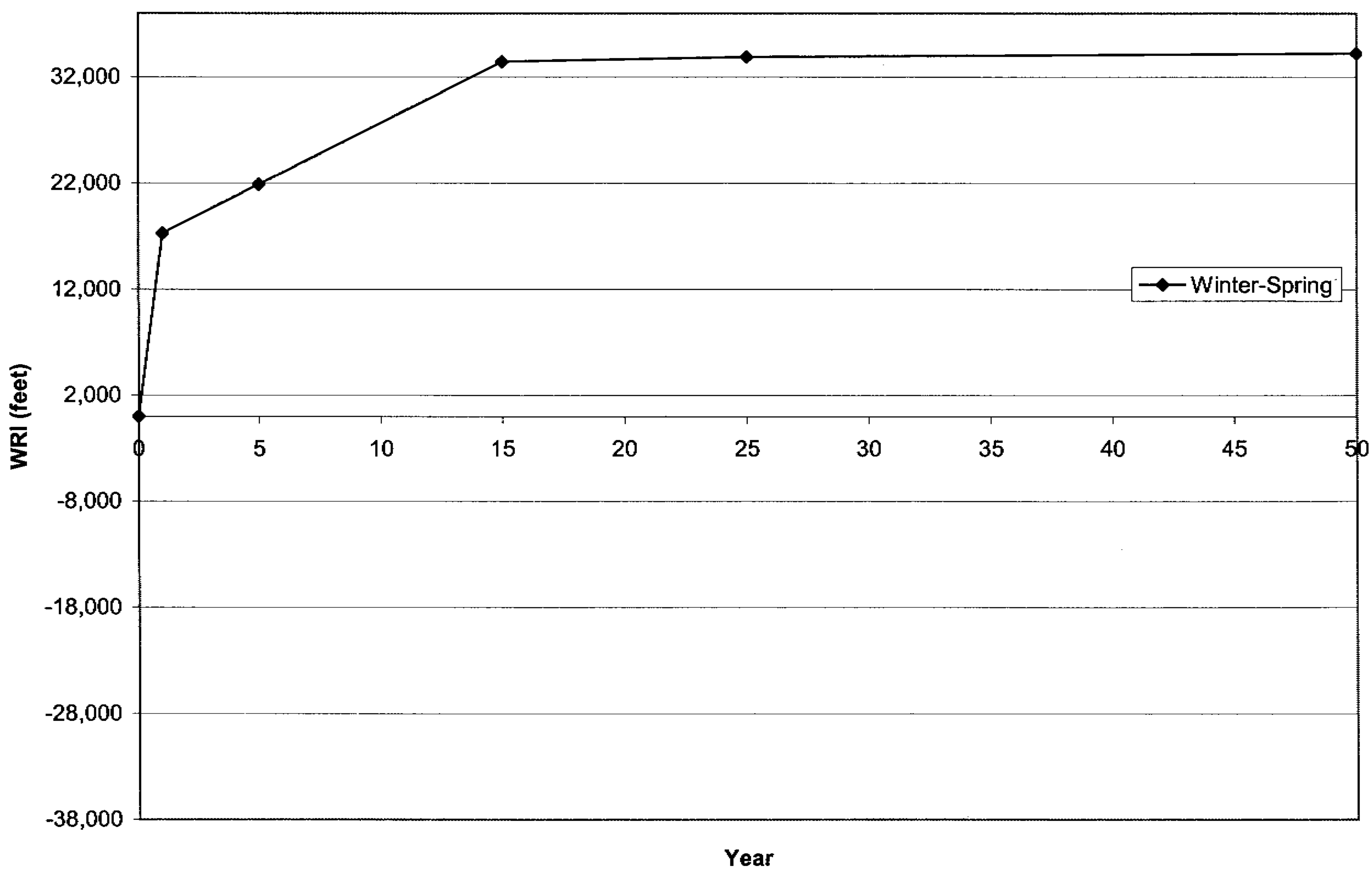
Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	-2960.87	-7325.52
5	-3438.46	-8787.10
15	-4632.44	-12441.07
25	-3896.17	-11298.96
50	-3416.85	-10492.18

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	17293.95
5	21905.67
15	33434.97
25	33891.57
50	34228.31

Delta Smelt Spawning and Incubation
Cache RM 16.5



Cache 16.5 WRI Values (bankline weighted - feet)

Chinook Salmon

	Juvenile Rearing		Smolt Migration	
Year	Fall	Winter-Spring	Fall	Winter-Spring
0	0.00	0.00	0.00	0.00
1	-4.39	-12.44	-23.28	-63.40
5	-5.57	-14.66	-29.49	-77.16
15	-8.49	-20.20	-45.01	-111.57
25	-6.57	-17.63	-40.16	-105.53
50	-2.56	-15.93	-29.67	-102.35

Steelhead

	Juvenile Rearing	Smolt Migration
Year	Winter-Spring	Winter-Spring
0	0.00	0.00
1	-19.61	-48.51
5	-22.77	-58.19
15	-30.68	-82.39
25	-25.80	-74.83
50	-22.63	-69.48

Delta smelt

	Spawning/Incubation
Year	Winter-Spring
0	0.00
1	114.53
5	145.07
15	221.42
25	224.45
50	226.68

Delta Smelt Spawning and Incubation
Cache RM 16.5

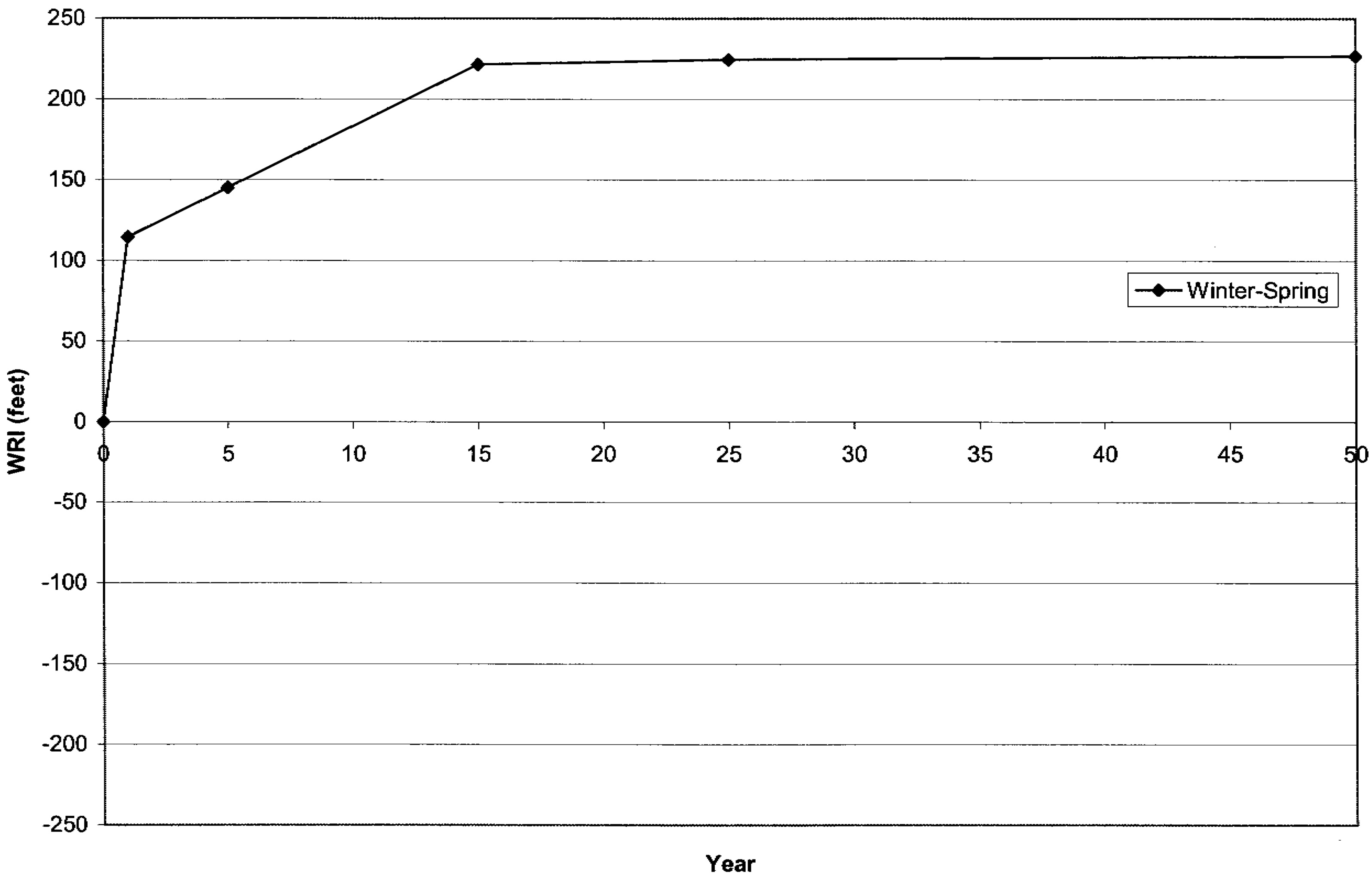


Table 15a. Site: Cache Slough 21.8 R – SAM Input Values for Existing Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.4	3.4
Water Surface Elevation During 2-year Flood (Q_2)	na	6.3
Q_2 ½-width	na	593
Shoreline Site Length (feet) (L)	2,455	2,455
Channel ½-Width (feet) (W)	579	582
Wetted Area (square feet) (LxW)	1,421,445	1,428,810
Bank Slope (dW:dH) at 0-3 ft depth	3.0 : 1	2.8 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.02
Bank Substrate Size (D_{50} in inches)	0.01	0.01
Instream Structure (% shoreline)	5	5
Vegetation (% shoreline)	0	90
Shade (% shoreline)	10	10

Table 15b. Site: Cache Slough 21.8 R – SAM Input Values for With-Project Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.4	3.4
Water Surface Elevation During 2-year Flood (Q_2)	na	6.3
Q_2 ½-width	na	582
Shoreline Site Length (feet) (L)	2,455	2,455
Channel ½-Width (feet) (W)	559	561
Wetted Area (square feet) (LxW)	Same as pre-project	
Bank Slope (dW:dH) at 0-3 ft depth	2.8 : 1	2.7 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.04
Bank Substrate Size (D_{50} in inches)	11.5	11.5
Instream Structure (% shoreline)		
Year 1	5	5
Year 5	5	5
Year 15	5	5
Year 25	2	2
Year 50	2	2

Vegetation (% shoreline)		
Year 1	0	0
Year 5	0	0
Year 15	0	0
Year 25	0	0
Year 50	0	0
Shade (% shoreline)		
Year 1	0	0
Year 5	0	0
Year 15	0	25
Year 25	0	25
Year 50	0	25

Cache RM 21.8 WRI Values (area weighted - square feet)

Chinook Salmon

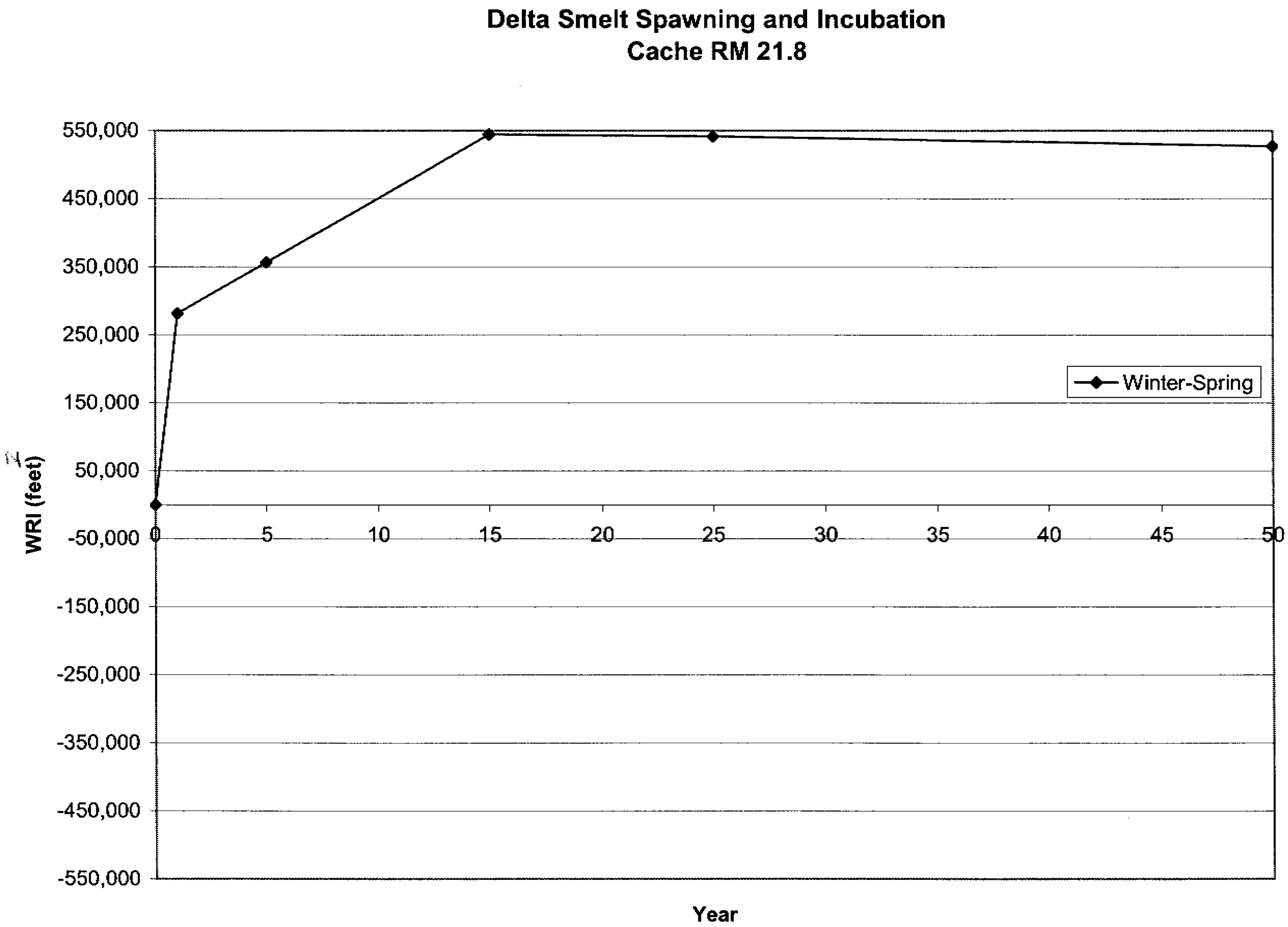
Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	-8105.86	-22757.60	-57391.82	-152396.05
5	-10267.43	-27650.90	-72696.31	-187137.06
15	-15671.34	-39884.14	-110957.52	-273989.60
25	-16201.41	-37791.53	-115270.26	-264918.93
50	-16991.35	-36961.62	-121982.68	-262340.49

Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	-40270.40	-128979.93
5	-48473.80	-156898.71
15	-68982.29	-226695.65
25	-64199.57	-215997.20
50	-62165.57	-212966.53

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	281617.92
5	356716.04
15	544461.32
25	541935.66
50	527497.06


Delta Smelt Spawning and Incubation
Cache RM 21.8
550,000
450,000
350,000
250,000
150,000
50,000
-50,000
-150,000
-250,000
-350,000
-450,000
-550,000
WRI (feet)
0
5
10
15
20
25
30
35
40
45
50
Year
Winter-Spring

Cache 21.8 WRI Values (bankline weighted - feet)

Chinook Salmon

	Juvenile Rearing		Smolt Migration	
Year	Fall	Winter-Spring	Fall	Winter-Spring
0	0.00	0.00	0.00	0.00
1	-14.00	-39.10	-99.12	-261.85
5	-17.73	-47.51	-125.55	-321.54
15	-27.07	-68.53	-191.64	-470.77
25	-27.98	-64.93	-199.09	-455.19
50	-29.35	-63.51	-210.68	-450.76

Steelhead

	Juvenile Rearing	Smolt Migration
Year	Winter-Spring	Winter-Spring
0	0.00	0.00
1	-69.19	-221.62
5	-83.29	-269.59
15	-118.53	-389.51
25	-110.31	-371.13
50	-106.81	-365.92

Delta smelt

	Spawning/Incubation
Year	Winter-Spring
0	0.00
1	483.88
5	612.91
15	935.50
25	931.16
50	906.35

Delta Smelt Spawning and Incubation
Cache RM 21.8

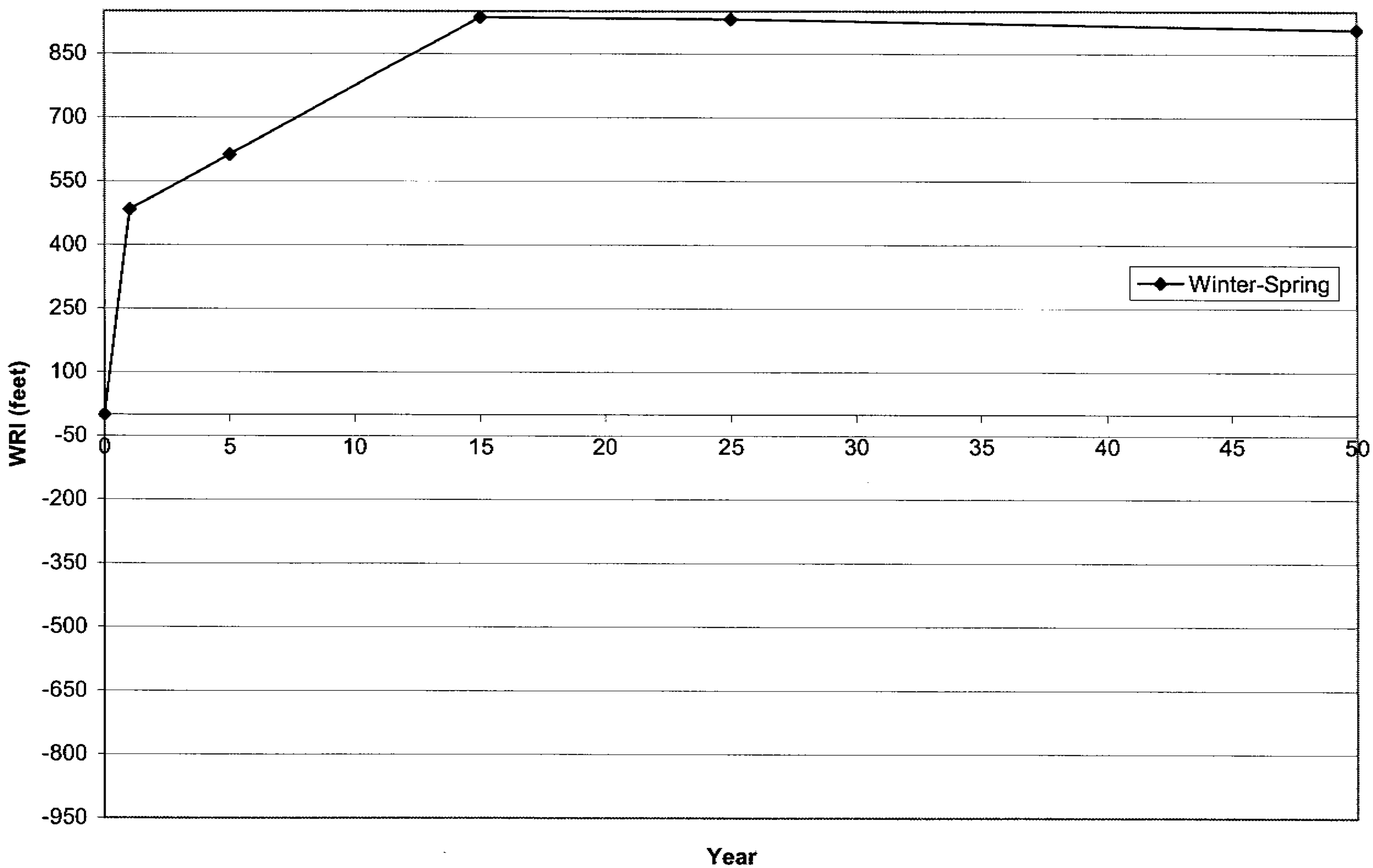


Table 16a. Site: Steamboat Slough 16.2 R – SAM Input Values for Existing Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.1	2.7
Water Surface Elevation During 2-year Flood (Q_2)	na	6.2
Q_2 ½-width	na	204
Shoreline Site Length (feet) (L)	230	230
Channel ½-Width (feet) (W)	200	201
Wetted Area (square feet) (LxW)	46,000	46,230
Bank Slope (dW:dH) at 0-3 ft depth	1.4 : 1	1.4 : 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.01
Bank Substrate Size (D_{50} in inches)	20 [a]	20 [a]
Instream Structure (% shoreline)	5	5
Vegetation (% shoreline)	0	63
Shade (% shoreline)	3	3

[a] Corps longitudinal type: 100% large rock (>20")

Table 16b. Site: Steamboat Slough 16.2 R – SAM Input Values for With-Project Conditions

	Season	
	Summer-Fall	Winter-Spring
Average Water Surface Elevation (feet)	2.1	2.7
Water Surface Elevation During 2-year Flood (Q_2)	na	6.2
Q_2 ½-width	na	185
Shoreline Site Length (feet) (L)	230	230
Channel ½-Width (feet) (W)	168	170
Wetted Area (square feet) (LxW)	Same as pre-project	
Bank Slope (dW:dH) at 0-3 ft depth	2: 1	2: 1
Floodplain Inundation Ratio (W_{Q2}:W_{Qavg})	na	1.09
Bank Substrate Size (D_{50} in inches)	11.5	11.5
Instream Structure (% shoreline)		
Year 1	5	5
Year 5	5	5
Year 15	5	5
Year 25	2	2
Year 50	2	2

Vegetation (% shoreline)		
Year 1	0	8
Year 5	0	15
Year 15	0	30
Year 25	0	40
Year 50	0	40
Shade (% shoreline)		
Year 1	0	0
Year 5	0	0
Year 15	0	0
Year 25	50	50
Year 50	50	50

Steamboat RM 16. WRI Values (area weighted - square feet)

Chinook Salmon

Year	Juvenile Rearing Fall	Juvenile Rearing Winter-Spring	Smolt Migration Fall	Smolt Migration Winter-Spring
0	0.00	0.00	0.00	0.00
1	23.03	-30.25	76.71	-1319.23
5	29.17	-6.50	97.17	-1356.85
15	44.52	52.89	148.31	-1450.90
25	36.32	254.96	64.03	-516.31
50	19.15	627.66	-107.10	905.90

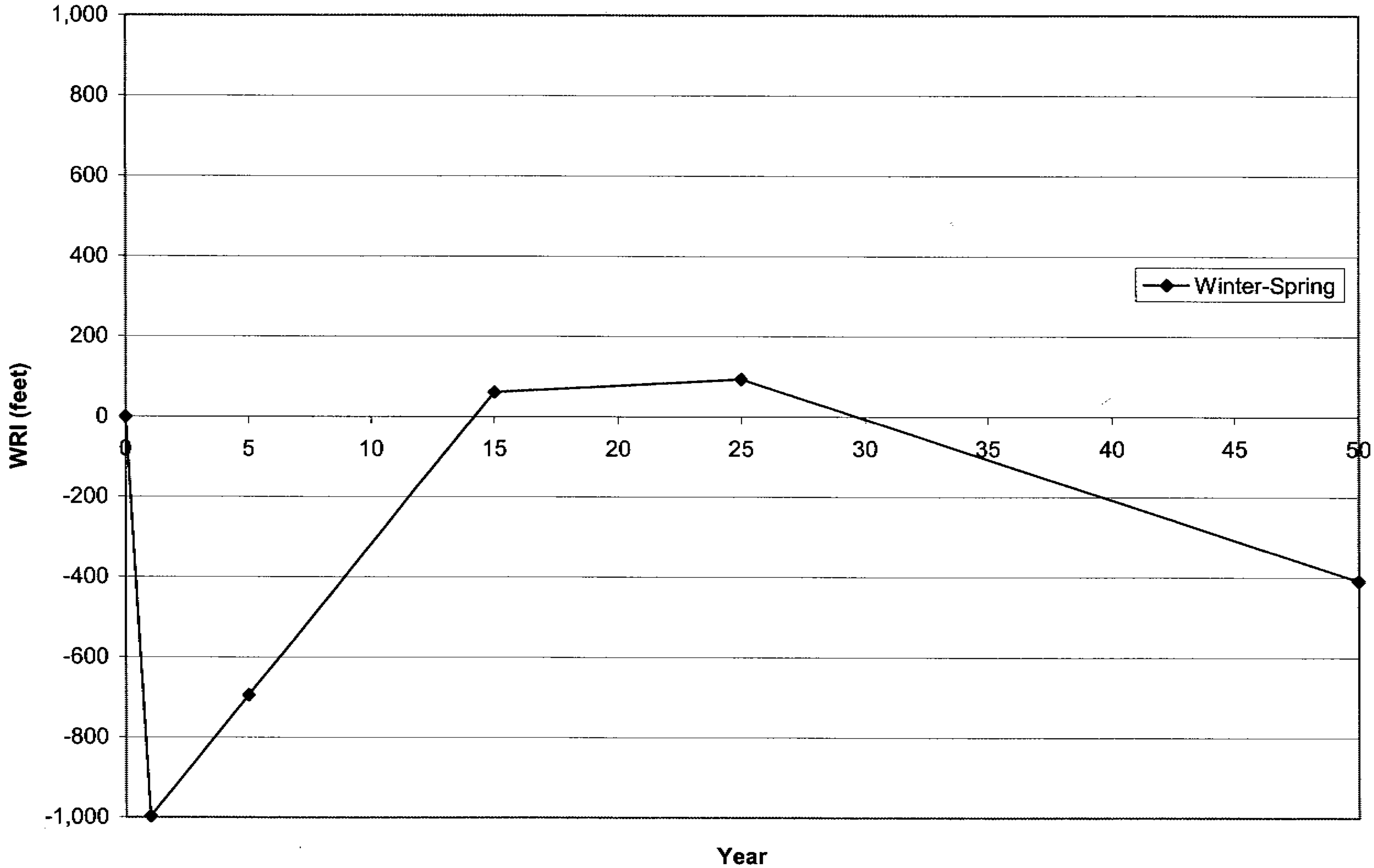
Steelhead

Year	Juvenile Rearing Winter-Spring	Smolt Migration Winter-Spring
0	0.00	0.00
1	14.95	-1001.05
5	84.89	-939.44
15	259.72	-785.44
25	638.79	113.92
50	1328.39	1491.19

Delta smelt

Year	Spawning/Incubation Winter-Spring
0	0.00
1	-997.13
5	-694.85
15	60.85
25	93.12
50	-409.40

Delta Smelt Spawning and Incubation
Steamboat RM 16.2



Steam 16.2 WRI Values (bankline weighted - feet)

Chinook Salmon

	Juvenile Rearing		Smolt Migration	
Year	Fall	Winter-Spring	Fall	Winter-Spring
0	0.00	0.00	0.00	0.00
1	0.12	-0.15	0.38	-6.56
5	0.15	-0.03	0.49	-6.75
15	0.22	0.26	0.74	-7.22
25	0.18	1.27	0.32	-2.57
50	0.10	3.12	-0.54	4.51

Steelhead

	Juvenile Rearing	Smolt Migration
Year	Winter-Spring	Winter-Spring
0	0.00	0.00
1	0.07	-4.98
5	0.42	-4.67
15	1.29	-3.91
25	3.18	0.57
50	6.61	7.42

Delta smelt

	Spawning/Incubation
Year	Winter-Spring
0	0.00
1	-4.96
5	-3.46
15	0.30
25	0.46
50	-2.04

Delta Smelt Spawning and Incubation
Steamboat RM 16.2